THE
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THE INVENTIONS OF EMPLOYES.

THE owners of engineering works who employ a large number of skilled workmen are frequently confronted with the question—How far is a mechanic, who works out an invention in our time and with our materials, entitled to obtain a grant of letters patent for, and the full benefit of, such an invention? The question is further complicated by the fact that the "idea," which, after all, is the most valuable part of every invention, is often suggested in the construction of some article which the workman is expressly ordered to make, or in the carrying out of some work on behalf of the firm. Thus it occasionally happens that a mechanic lights upon a labour-saving device of enormous value. We may instance what occurred in the early days of the locomotive before the slide valve was invented. A man was employed to open and close the throttle valve as the wheels rotated, in order to admit the steam at the proper time. He found, however, that by causing the wheel to do the work itself by means of a cam or some similar device, the engine would run automatically, and his labours were considerably lightened. Similar examples might be found in every modern workshop. Indeed, many of the most valuable mechanical principles have been turned to practical account in a rough and ready way by workmen inspired by the desire to do as little as possible, rather than by any pronounced inventive genius.

Seeing that the merit of an invention discovered under the foregoing circumstances must really belong to one or more persons, it is interesting to inquire into the position taken up by an English Court when a question of title to letters patent is brought up. In Heald's case (8 R.P.C., 430), which was decided some years ago, a workman was held entitled to have a patent sealed in his own favour, although the company for which he worked contended that he had made the discovery while occupied upon their business.

In a recent case, however, it appeared that the late manager of a firm who manufactured a particular kind of pump, claimed to be entitled to the benefit of certain patents and improvements which he had worked out while so employed. The Court held that, having regard to all the circumstances of the case, this claim could not be maintained. The question, indeed, is one of fact to be decided according to the merits of each particular case. At the same time, it is clear law that if a workman is employed to make a model of a machine or device in respect of which his master desires to take out a patent, suggestions made by the workmen cannot be patented by him, but in fact belong to the employer and merge in his invention. Hence he is the only person entitled to a patent for them. It follows that improvements in details suggested by such workman, and embodied in the machine, do not entitle him to oppose and stop the master's patent, on the ground that material parts

of the invention have been obtained from him. (David *v.* Woodley, Griff, A.P.C., 26.)

We have said enough, however, to show that it is highly desirable that the exact position of master and servant with regard to inventions, should be made clear at the commencement of the employment. Further, apart from patent rights, there are methods peculiar to every manufacture which the employer frequently desires to conceal from the public gaze. In order to preserve this secrecy, it sometimes becomes necessary to place his workmen, who are naturally *au fait* with every detail of the manufacture, under some obligation not to divulge anything to the outside world. Something in writing is practically necessary, although the common law declares that no workman is entitled to divulge any secrets of his employers, and this whether he is still in their service or no.

An esteemed contemporary* has recently published the text of an agreement which some firms in America ask their employés to sign before entering service. In brief, the contract, after reciting the fact that the employé, by reason of his employment and the nature of the work which he has to do, will come into possession of certain knowledge concerning the business which it is not desirable that competitors should possess, binds him not to divulge such information to anyone. The rest of the agreement relates to inventions, and to the title to patents which may be taken out therefor. It provides that—

Any invention made by the employé pertaining to the company's product of work shall be made known to the company or its representative, and if thought worth while by the company, a patent is to be taken out at the expense of the company, which is to have exclusive right to its use so long as the inventor remains in its employ. Should he leave, however, the right ceases to be exclusive. It provides further, that when the company desires to obtain full control of the invention, it can do so by payment of a sum to be agreed upon, and this may be done either during the continuance of the employment or after, the company having the first right to purchase within a specified time, after the expiration of which the employé is at liberty to dispose of his invention to anyone else.

The exact words of the "secrecy" clause are as follow:—

That during the said employment he (meaning the workman) will devote his time, best skill, and ability to the interests of the business of the first party, and that he will not directly or indirectly divulge to any person, firm or corporation any information as to the said plans, drawings, models or machinery of the first party or methods employed by it in the operation of its business or in reference to its machinery, or the manufacture of machinery or any apparatus connected therewith, or in the conduct of its business.

The clause with regard to inventions reads as follows:—

If the second party during the said employment shall devise or invent any improvement in the machinery or processes employed in the works of first party, or in the machinery manufactured in its works, or used in connection with the machinery used, sold or manufactured by first party or in any apparatus connected therewith, the second party will immediately after making such invention disclose the same to the manager of the department in said works in which second party is then employed, or to the person who has charge of such matters for first party, and if it is so desired by first party, the second party will, at the expense of first party, make application for Letters Patent from the United States, or any foreign country or countries, for such invention or improvement, and will by formal assignment grant and convey to first party, its successors or assigns, the permanent shop right or license under such patent, patents or applications; the same to cover any or all of the first party's shops now located or to be located within the United States or elsewhere; and

Said license or shop right when so given shall be an exclusive right or license, and shall operate as long as said second party remains in the employment of the first party, after which it shall not be exclusive.

Second party further agrees, at any time during the continuance of his employment or at other times as are provided herein, that he will at request of said first party, it successors or assigns, by formal agreement convey to the said first party, its successors or assigns, all right, title and interest in and to such invention in further consideration of the payment to him by first party of such sums of money as may be mutually agreed upon. It is also understood that if other parties desire to purchase such invention or inventions, the first party shall have the first opportunity of making such purchase at a price equal to that offered *bond fide* by any other party.

Said second party further agrees with said first party, its successors or assigns that whenever he leaves its employ, the said first party, its successors or assigns shall have first opportunity to purchase such patents, rights under patents or applications for patents, which he may then own or control, and shall have such option for the purchase of same for a period of . . . . days from and after the time said second party leaves the employ of said first party, its successors or assigns.

It is also agreed by both parties hereto that in case said second party shall have submitted to the said first party or its proper representatives, in accordance with this agreement, any invention or design, and said first party decides not to avail itself of the options first above mentioned and herein given within sixty (60) days and the option last above mentioned within . . . . days, then and in that event the said second party shall make such disposition and use of such invention as his will may dictate, and as though this indenture had not been made.

This document, which was apparently drawn up by an American lawyer, embodies a number of suggestions which may be usefully noted by English manufacturers. Although an ingenious workman might in some degree sign away his rights by attaching his signature when entering an employment, yet he would have the inestimable advantage of his employer's capital to assist him in defraying the necessary cost of bringing an invention to perfection. In this respect the adoption of the suggested form of agreement might have the effect of promoting rather than hindering the progress of invention on both sides of the Atlantic.

* The *American Machinist*, April 18th, 1903.

The Supply of Small Towns.

In our article upon "The Local Government Board and Municipal Enterprise" (Electrical Review, April 10th, 1903), we referred to the case of East Barnet Valley, and it is satisfactory to find that the course adopted by the Department has been fully justified by the result of the elections—the chairman and two other members of the Urban District Council who favoured the scheme having been rejected—and in consequence the Local Government Board has decided upon not proceeding with the application for a loan, and the newly-elected Council has withdrawn the proposed undertaking; a useless expenditure has been incurred which might have been saved had the opinion of the ratepayers been taken before embarking upon the scheme, but in cutting the first loss the interests of the district will doubtless be best served.

Another case of a small town where the grant of the loan applied for has been refused is that of Dungannon, in the Province of Tyrone, the Irish Local Government Board having decided, after taking the evidence at the usual inquiry, that the suggested municipal trading is not justified. In this case the scheme prepared by the consulting engineer—Mr. Cruise—appears to have been well designed, and the opposition was fostered by the gas interest, but for such a small town (population, 4,000) it should form an item in a power scheme covering a large area, if an economical supply is to be given.

It is satisfactory to find the Local Government Board recognising the wishes of the ratepayers, but when Parliament can be induced to consider amendments in the Electric Lighting Acts and the powers of local authorities in promoting undertakings, salutary provisions should be

obtained for giving the ratepayers control before heavy expenses are incurred in preparing schemes.

The theory that a local authority must be taken to represent the community that elects it, can only hold good so far as it relates to the ordinary affairs connected with local management—which existed at the time of their election—but any new departure, such as an application for an electric lighting or tramway order should be submitted to the ratepayers, and their vote taken before any costs are incurred. Under the existing system, a large outlay is often made before it becomes necessary to submit the matter to the ratepayers, so that when the formal sanction of the Local Government Board to a loan is applied for, a considerable amount has been spent in obtaining the provisional order, and upon consulting engineer's fees for preparing a scheme, &c., which is thrown away, if, as in the cases we have referred to, the loans are refused, and the undertakings abandoned.

If the memorials to the Board of Trade for grant of provisional orders to local authorities had to be accompanied by evidence of the sanction of the ratepayers by poll, it would at all events establish the fact that a majority favoured the application, and prevent much needless expenditure, if such evidence were not forthcoming.

The desire of the local authorities of small towns to be relieved of the responsibilities of undertakers under their electric lighting orders, appears to be on the increase, and as a great many provisional orders granted years ago have never been worked, the Board of Trade may be expected to revoke them and open the way for private companies to include such towns in their up-to-date schemes.

In a list published by a contemporary a week or two ago, the names of 106 local authorities are enumerated as possessing Provisional (Electric Lighting) Orders, the works for which have not yet been decided upon, and of this number about 30 are from three to five years old, the periods for supply of the compulsory areas having long since passed; in some cases of a more recent date, orders granted to the local authority after successful opposition to applications by companies, are now in the market, the municipalities having decided not to work them.

Expert Evidence.

FOLLOWING on the line usually adopted by an enlightened government, as an antidote to the alarmist opinions of our sensational press, we have at present sitting an official committee to inquire into the uses and abuses of electricity in mines. Now, the possibilities of such a committee undoubtedly depend on its capacity for separating the wheat from the chaff, the accurate from the inaccurate and the superficial from the expert evidence which is submitted to it. No doubt the committee has chosen nothing but expert evidence, so far as it is able to gauge it, and with the evidence, which we record on another page, advocating a progressive policy and unrestricted methods, no one will disagree. It is, however, possible that the lay mind will question the value of such evidence when the giver admits that his last practical experience dates back to the "early days," even though he has many schemes "under consideration" at the present time. Again, the records of manufactures on the Continent, and over the whole world, for that matter, are open to the committee, should they inquire for them; but this is not practical evidence of the working, nor does it reveal the numerous circumstances which crop up under the varied conditions associated with gassy and wet mines. One cannot help feeling dissatisfied with the unstable evidence on constructional details, and in the matter of foreign imports of electrical lighting and tramways material into Great Britain, which have only found ready access through the municipal muddling of certain towns, the evidence is somewhat misleading, ignoring as it does what is being and has been done by English firms, not only in these branches, but also in continuous and polyphase mining plants.

ELECTRIC HAULAGE ON CANALS.

THE problem of restoring to our overland waterways a measure of their original prosperity and importance, has induced engineers in Europe and America to devise many schemes for increasing the efficiency of our much-neglected canals. Cheap transport in the present age of keen business competition is of vital importance to a manufacturing community, and at the present time our traders look forward to in some measure attaining this desirable end by means of the electric tramway and light railway networks, which are assuming extensive proportions in populous districts, and by the aid of motor wagons which have advantages in the way of unrestricted routes.

Decreased as freight charges will, undoubtedly, be by these means, it is yet not too much to say that for large volumes of bulky traffic, no method of transport yet devised can compete with the canal in the matter of cheapness of transport, and there is every reason to believe that with the advent of regular and accelerated services of boats these overwhelming advantages will be readily recognised.

We have at the present time about 4,000 miles of canals and navigations in Great Britain, of which over 1,000 are controlled by railway companies.

Of the uncontrolled canals, there are some 130 different waterways, having over 100 different proprietors, and largely built to different gauges, features which though adding difficulties in some directions are not unsurmountable.

A few years ago our canals and inland navigations were credited with carrying over 36,000,000 tons of merchandise per annum. As previously mentioned, numerous attempts have been made to improve the efficiency of canal haulage, by the substitution of mechanical and electrical for animal power.

Tests on the Thwaite-Cawley system of haulage, being figures derived from actual working, show the comparative cost per H.P. for a 12-hours day to be as follows:—Electrical, 1s.; steam tug, 1s. 8½d.; horse, 3s. 11½d.; and in the case of the Aire & Calder navigation steam tugs reduced the cost per ton-mile from ·14d. by horses to ·03d. On several of the largest canal systems the cost for horse haulage is about ·3d. per ton-mile.

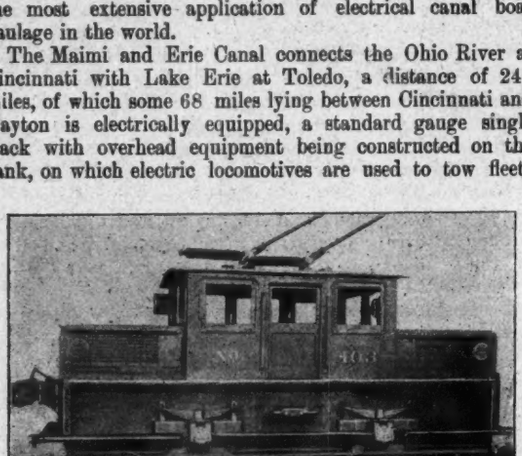
It is clear that improved methods will greatly reduce the already low costs.

Electrical methods of canal haulage have naturally received less attention, so far, than others, but both on the Continent and in America electrical haulage is in use. A French canal company uses an electrical towing loco., running on a single guide rail on the bank, capable of towing two 300-ton barges at a speed of about two miles per hour. The motors are rated at 13 H.P., and take continuous current at 500 volts. In Germany a system controlled by Siemens and Halske is in operation on the Finow Canal, which makes use of a narrow-gauge railway upon the canal bank. Another system has been installed experimentally upon the Dortmund-Ems Canal, but the most complete system of this kind is that on the Charleroi Canal at Brussels, Belgium. The canal is very narrow and about 50 miles long, and connects the Charleroi coal district with the port of Antwerp, passing through Brussels. A number of small electric automobiles rated at about 5 H.P. capacity take the place of the horses previously used. These automobiles are connected with an overhead system, which consists of feeder wires carrying current at 6,000 volts, and trolley wires carrying the operating current at 600 volts. The main current is supplied by two power stations, which are 29 miles apart, and this current is reduced to 600 volts at sub-stations located three miles apart along the entire distance of 50 miles. The automobiles operate over sections of varying lengths, each motor towing one boat until it meets one travelling in the opposite direction, when the two exchange tow lines and retrace their routes. In England the question of establishing electric haulage on the River Lea from Hertford to Walthamstow, a distance of about 18 miles, is under consideration, while America has since 1893 experimented with various overhead trolley, cable way, and loco. systems of electrical canal haulage.

In this connection the American *Street Railway Review*, to which we are indebted for the accompanying illustrations, describes a system of haulage for canal boats which is being

installed on the Maimi and Erie Canal, involving the use of a three-phase system of electric traction which is probably the most extensive application of electrical canal boat haulage in the world.

The Maimi and Erie Canal connects the Ohio River at Cincinnati with Lake Erie at Toledo, a distance of 244 miles, of which some 68 miles lying between Cincinnati and Dayton is electrically equipped, a standard gauge single track with overhead equipment being constructed on the bank, on which electric locomotives are used to tow fleets



Electrical Towing Loco, Maimi and Erie Canal.

of from five to seven boats, the capacity of this section being 100 boats per day.

The construction of this canal—and, indeed, its period of prosperity—dates back to the period before railway systems existed. The territory through which it passes contains over five millions of people, and it touches 18 towns and many manufacturing concerns.

The profile of this canal is very irregular, involving the use of 95 locks, its highest point above the River Ohio being 512 ft. at the Laramie Summit.

The breadth of the canal at water level varies from 36 to 50 ft., with a depth of from 4 to 6 ft.

For several years past the losses incurred in the operation of the canal have been made up by the State, which owns the line; but recently an arrangement has been concluded with the Maimi and Erie Canal Transportation Co. for a period of 30 years, by which the company provides the hauling equipment and undertakes the transport of boats.

The company is prohibited from interfering with the ordinary use, control and management of the canal, and the franchise does not limit the powers of the Board of Public Works as fixed by law. It is also compelled to transport all boats along the canal when the owners of them shall so desire, and in case of disagreement as to the price for propelling boats, the company is subject to such regulations in regard to charges as may be prescribed from time to time by the Board. The speed is limited to four miles per hour.

The specifications of the State Board of Public Works provide that all road-bed construction shall, wherever practicable, be 2 ft. above the standard level of the canal, the company to build retaining walls or pile construction where necessary to receive the inner rail of the track, and the ballast of the road-bed to be filled over the top of the ties so as to give a smooth surface for the present method of towing by mules and horses. The company is authorised to build and operate as many swing bridges as will be necessary for the operation of the road.

According to the terms of the franchise the entire track between Cincinnati and Toledo, a distance of 244 miles, is to be finished and in operation by the year 1907. In the section completed the road-bed is laid with 70-lb. rails on oak ties. It is substantially constructed, and where the locks occur, the track is built on trestles from the high down to the low level, so that the gradients have been maintained within a maximum of 1½ per cent.

Turn-outs have been arranged at suitable points for passing locomotives; one bond is provided to each rail joint, and there are no cross bonds. In a number of places where the road passes under bridges the road-bed dips down below the surface of the water in the canal, and at these places concrete retaining walls have been built, some 5,019 ft. of these concrete walls having been built up to the present time. In places where the banks are narrow and the track close to the water it was necessary to built retaining walls to support the weight of the locomotives on the banks. These walls were built of piling driven close together, along which 3 in. oak planks were bolted, 11,488 ft. of piling having been put in.

In the illustration of the pole construction are shown the high tension feeders, which are run in the form of a triangle, two phases being carried upon the lower cross-arm and one on the upper cross-arm centrally above the other two. These are carried on Locke porcelain insulators without gutters. The feeders are stranded aluminium wire equivalent to No. 0 copper. The three-phase circuit for the locomotives is carried on two overhead trolley wires with track return. On account of the numerous bridges under which the trolley wires have to pass, the height of these wires above the track is very variable, being 22 ft. high in some places and as low as 7 ft. under some of the bridges in the city of Cincinnati. The minimum height of the trolley wires outside of the city is 9 ft.

The trolley wires consist of two No. 0000 G.E. groove wires carried for the principal part of the way on flexible brackets, with double insulated fittings. At swing bridges and places where it has been necessary to run the high tension feeders on the side of the canal opposite to the tracks, to avoid buildings and other obstructions, span wire construction has been used. The part of the work already completed has been by far the most difficult, owing to the number of buildings and other obstructions, which have been put up close upon the banks of the canal during the past few years when the operation of the canal was practically suspended.

The company takes its energy from the Cincinnati Gas and Electric Co., which has a plant on the bank of the canal near the Cincinnati terminus. This company furnishes three-phase current of 60 cycles at 4,000 volts pressure, which is stepped down to 400 volts at the sub-stations and two-phased by the Scott method of connection of transformers. This two-phase current is led to a 450-H.P. two-phase synchronous motor, coupled to a three-phase, 25-cycle, 300-KW. generator, giving a pressure of 390 volts. Thence the current is led to 250-KW. transformers and stepped up to 33,000 volts for the transmission line.

Pole and Overhead Construction, Maimi and Erie Canal.

At points about 12 miles apart there are static transformer sub-stations, each of which is to be equipped with three 150-KW. transformers permanently connected in delta.

These transformers will step the three-phase current down from 33,000 to 1,090 volts, which is the voltage of the trolley circuit.

The sub-stations will be provided with Westinghouse low-equivalent lightning arresters and static interrupters. The buildings being of concrete and expanded metal, are absolutely fire-proof.

The company has at the present time seven 20-ton locomotives contracted for, four of which have been delivered. The cabs of six of the locomotives are built so as to clear the trolley wires at a height of 9 ft., and one, to be used for switching purposes in the city of Cincinnati, is built to pass under trolley wires 7 ft. high. The frames, which are 14 ft. in length, are mounted on Baldwin trucks, having 30-in. wheels and a 7-ft. wheel base. The weight complete is about 24 tons each, and the motors are connected to the axles through double reduction gearing. The draw-bar pull with three-phase current at 1,100 volts, and with an efficiency of 95 per cent. for each pair of gears, is as follows :—

Coefficient of adhesion.	Draw-bar pull.
25 per cent.	9,600 lbs. starting.
20 per cent.	7,600 lbs. starting.
16 per cent.	6,350 lbs. starting.

The equipment of each locomotive includes two induction motors connected in concatenation and provided with rheostatic control. The variable resistance is in the rotor of either of the motors, which are rated at 80 H.P. each, and wound for 200 volts. This voltage is obtained through transformers on the locomotives, which step the trolley current down from 1,090 to 200 volts. The maximum speed of the locomotives using one motor is 6 miles per hour, and the operating speed with two motors in tandem is between 3 and 4 miles per hour. The motors are guaranteed to run for 10 hours at full load with a maximum rise of temperature of 75° C.

That part of the trolley circuit inside the city of Cincinnati will be operated at a pressure of 390 volts, as a precaution of safety, instead of 1,090 volts, and the locomotive transformers are provided with auxiliary connections to utilise this voltage inside the city. Changes in the transformer connections can be made by means of switches in crossing to the city line.

The electrical apparatus of the entire equipment is of the Westinghouse type, and the engineering and construction work has been done by the Cleveland Construction Co., of Akron, O.

In the practical operation of the system a string or fleet of canal boats, from five to seven in number, will be towed by a single locomotive. Owing to the narrowness of the channel and the surging or piling up of the water in front of the boats, it has been found necessary to use tow lines of about 200 ft. in length between each of the boats and between the forward boat and the locomotive. The tow line is fastened to the locomotive by means of a swivel draw bar.

At the points where the road crosses from one side of the canal to the other, swing bridges have been constructed, over which the locomotives pass. After the locomotives have passed, the bridge will be opened for the boats to pass through. The question of bridges has proved a troublesome one on the first part of the line, as 135 highway bridges have had to be redesigned or reconstructed to provide sufficient clearance for the overhead system.

When two fleets of boats pass on level parts of the canal turnouts are provided so that one locomotive may take the loop and drop its tow line while the other one passes over on the straight track. The schedules are arranged, however, so far as possible, that the crossing of the boats will take place at the locks. The locks are 90 ft. in length, providing room for only one boat to pass at a time. In running into a lock and floating a boat up or down to the next level about eight minutes per boat is allowed, although under favourable conditions a boat may be put through the lock in about four minutes. When two lines of boats are passing at the locks considerable time is saved, as instead of allowing the lock to fill up, when emptied after the down-stream boat has passed, one of the boats in the opposite direction is put into the lock and floated up to the next level, thus occupying no more time. It has been found from experiment that freight may be hauled in canal boats by this system at a cheaper rate than it can be towed by mules, the power required being only about 10 H.P. per boat when towed at a speed of four miles per hour.

The boats used are 70 ft. long, 10 ft. wide, and have a capacity of about 70 tons each, the company is building its own boats.

The operating expenses are extremely small as, in addition to the small amount of power required per boat, only one man is required on each boat for steering, and one man on the locomotive. The company is establishing large warehouses and depôts at various points along the route. To deal with the traffic which came to it, before the equipment was complete, the company had to put up a temporary plant, and during the past winter has worked a regular service to schedule times over the portion of its route which was completed.

THE TESTING OF ALTERNATE CURRENT SWITCHES AND FUSES.

By G. W. HOWE, B.Sc., Whit. Sch.

It is now generally recognised that the severity of a test on the circuit-breaking capabilities of a switch or fuse is not only dependent on the current and voltage, but on the power factor of the current broken. The effect of the power factor on the energy of the arc formed can readily be shown. We assume, in the first case, that the switch or fuse is in series with a resistance r and an inductance L, across terminals at which a constant potential E is maintained. The normal current will be $C = \frac{E}{\sqrt{r^2 + w^2 L^2}}$. As the switch is opened, an additional resistance is introduced into the circuit, viz., that of the arc, and at any moment the current $C_1 = \frac{E}{\sqrt{(r + r_1)^2 + w^2 L^2}}$, where r_1 is the resistance of the arc.

The voltage across the arc is $C_1 r_1$, and the power of the arc measured in watts $= C_1^2 r_1 = \frac{E^2 r_1}{(r + r_1)^2 + w^2 L^2}$.

During the opening of the switch, r_1 varies from 0 to ∞, but for a certain value of r_1 there is a maximum in the power of the arc, viz., when the differential of the power is equal to 0, that is, when $r_1^2 = r^2 + w^2 L^2$, therefore the maximum power of the arc

$$= \frac{E^2 (r^2 + w^2 L^2)^{\frac{1}{2}}}{2 (r^2 + w^2 L^2) + 2 r (r^2 + w^2 L^2)^{\frac{1}{2}}} \text{ watts.}$$

The power factor of the circuit was $\frac{r}{\sqrt{r^2 + w^2 L^2}} = \cos \phi$.

Hence maximum power of arc $= \frac{E C}{2} \left(\frac{1}{1 + \cos \phi} \right)$ watts,

and $$\frac{\text{Max. power of arc}}{\text{Power in circuit before breaking.}} = \frac{1}{2 \cos \phi (1 + \cos \phi)} = k.$$

For $\cos \phi = 1$ $k = \cdot 25$,
$\cos \phi = \cdot 5$ $k = \cdot 67$,
$\cos \phi = \cdot 1$ $k = 4 \cdot 55$,
$\cos \phi = 0$ $k = \infty$.

If, for example, a current of 100 amperes is opened in series with an inductive resistance across a constant voltage of 1,000 volts, the maximum number of watts in the arc is—

For $\cos \phi = 1 \cdot 0$. $100 \times 1{,}000 \times \cdot 25 = 25{,}000$ watts.
„ $\cos \phi = \cdot 1$. $100 \times 1{,}000 \times \cdot 1 \times 4 \cdot 55 = 45{,}500$ watts.

In the case of a generator short circuited through the switch or fuse, the constant potential is the induced or open circuit voltage, which is short circuited through the resistance and the inductance of the armature. The maximum number of watts in the arc will, in this case, be $\frac{1}{2}$ E C_s, where C_s is the short circuit current, that is approximately 1·5 E C if C is the normal current of the machine.

The foregoing considerations show that for a given current and voltage the test is severer if the current lags. A very convenient method of testing switches and fuses is to put them in circuit with a number of choking coils which, by means of variable air-gaps and alternative connections, allow of a wide range of currents and voltages. The power factor

being low, makes the test more severe than is perhaps necessary, but this is certainly a good fault, and can be allowed for as indicated above.

GERMAN ELECTRICAL INDUSTRY.

By G. W. HOWE, B.Sc., Whit. Sch.

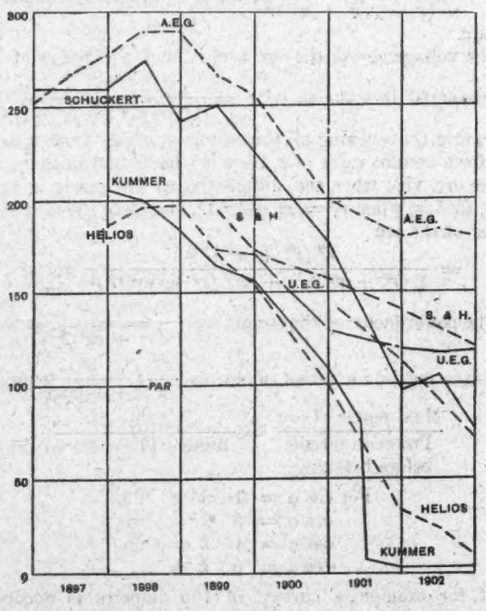
A glance at the accompanying diagram will enable one to realise more readily than by studying statistics the main features of the past six years of electrical industry in Germany.

The diagram represents the prices of shares of seven of the largest firms, taken from the German Stock Exchange quotations. The ordinates give the values as a percentage of the nominal value, and the abscissæ represent a period of six years, *i.e.*, from January, 1897, to December, 1902.

The firms are the Allgem. Elektr. Ges., Berlin; Schuckert and Co., Nürnberg; Siemens & Halske, Berlin; The Helios Co., of Cologne; Kummer & Co., Dresden; The Union Elek. Ges., of Berlin, and W. Lahmeyer, Frankfort.

The most striking feature in all cases is the continued falling off during nearly the whole time, or, as our mathematical friends would say, the strong negative value of $\frac{d\,£}{d\,t}$.

One of the firms, viz., Kummer & Co., stopped operations during 1901 and went into liquidation, their £5 shares being now quoted at from 9d. to 1s. 3d., whereas five years ago they were worth £10 each.



It is a strange coincidence that the word "kummer" in the German signifies "grief." Another company which is in no enviable position is the Helios, their record being rather suggestive of a sunset.

The diagram is worthy of the attention of English electrical engineers, and shows only too plainly the terrible dangers arising from over-capitalisation.

Morecambe Tramways.—The T.C. has formed a tramways committee to go into the question of electrifying the horse tramways. The Corporation is in communication with the B.E.T. Co., the company owning the present tramways, and a Bradford syndicate. The latter proposes to connect the Morecambe lines with those at Lancaster.

ELECTRICITY IN MINES.

A meeting of the Departmental Committee on Electricity in Mines was held at the Home Office on Wednesday, April 22nd. There were present Mr. Cunynghame, who acted as president, Mr. Stokes, Mr. Hood, Mr. W. N. Atkinson, and Capt. Desborough, secretary.

The early portion of the inquiry was of little electrical interest, but in the afternoon evidence was given by Mr. D. L. Selby-Bigge, consulting engineer and contractor, of Newcastle-on-Tyne, who referred to the early days of electrical work, when he had put up several isolated installations in Lord Durham's collieries, but owing to the backward state of electrical development in this country, he had since that time devoted his attention to electrical work in other directions.

At the present time he had several large schemes under consideration, and strongly advocated the use of three-phase alternating as against direct current electrical systems in mines, for reasons which are well known to English engineers.

He considered 700 volts the maximum and 500 the most practical working pressure in continuous current, as against 1,000 to 3,000 volts in three-phase work. He referred to the advantages of high-tension alternating machinery in insulation, in the high tension windings being stationary, in having no commutator, and in the case of induction motors underground having no rubbing parts at all. In the event of breakdowns a continuous current armature would have to be removed, but a faulty winding on an alternating machine could be cut out and bridged over.

In the case of a mine 1,000 yds. deep, to transmit 1,000 H.P. by continuous current at 500 volts to the pit bottom would cost in cables alone £4,000 — a prohibitive price. If a three-phase H.T. cable were used the cost would be £950.

A further advantage obtained in long-distance transmission, where, with the use of static transformers, any desired voltage could be made available at points on the line.

His opinion, that direct current systems were obsolete in mining work and for long-distance transmission, was confirmed by Continental experts (and we might add in the case of large powers, by a majority of English experts). If required, continuous current could be obtained by the use of rotary converters.

In connection with the Preussen Mine, near Dortmund, the following particulars of the performance of the electrical installation, which Mr. Selby-Bigge gave, were of interest.

Coal lifted net, 2 tons 3 cwt.; coal lifted per hour 100 tons; shaft 700 metres deep; speed per sec. lifting coal, 16 metres, men 5 metres, inspection ·5 metre, showing the possible variations. Starting took 16 secs., normal full speed 27 secs., slowing 18 secs., changing 17 secs., being a total, for run and change, of 78 secs.

The H.P. at starting was 1,380, running 650; system, three-phase, 2,000 volts, 25 periods, 50 alternations, number of revolutions of motors, 50; direct coupled drive; diameter of rope 45 millimetres, weight do., 14·8 lbs. per metre with two tubs per deck and two decks; weight of tubs 1 ton 4 cwt.; weight of cage 3 tons 14 cwt.; of coal 2 tons 3 cwt, and of rope 6 tons 8 cwt. Total weight of lift 13 tons 9 cwt. This plant was supplied by the A.E.G. Co., of Berlin, and they were bound by stringent conditions.

Speaking from memory, he thought the saving in coal consumption over the best steam practice was in the proportion of 16 to 26, and there was also a much steadier drive with a motor. Mr. Selby-Bigge then gave numerous instances of electrical colliery installations in Germany and Belgium. In 13 cases the plants varied from 1,500 to 3,000 H.P.; and in the case of 18 mines in Westphalia with 17 three-phase and one small continuous current plants were employed, the voltages varied from 1,000 to 2,000 (energy at these pressures being taken down the shaft for pumping purposes).

In other cases of 15 mines, employing horse-powers varying from 6,500 downwards, the voltages ranged from 3,000 to 1,200—three-phase system.

He had obtained the opinions of Continental experts representing over 100,000 H.P. installed in mines, and in specific cases into which he had inquired, the maximum voltages (2,000 to 3,000) were used for hauling and taken

down the shaft for pumping. At the bottom the voltage was stepped down to 500 for use on smaller plant further in the mine.

Cut-outs and fuses in air-tight cases, and earthed armouring, were employed to lessen breakdown risks, the universal practice being to employ oil break switches and fuses. High-tension apparatus is always enclosed—sometimes protected by earthed screens—and occasionally placed in padlocked chambers.

There was not a single instance of a fatal shock to the users; the great simplicity and careful casing-in of dangerous apparatus was a characteristic of the German plants.

It is usual to start up the larger motors down the shaft with the generating machinery—the switches in between being used only in emergencies.

He had always been obliged to go abroad for machinery, and considered that restrictive measures as to voltage would suppress progress in mining work, but rules might be framed, which, while leaving the selection of the plant to the engineer, would discriminate against inferior work. In regard to cables the armoured type was not necessary in all cases, and he thought it would be sufficient to specify the insulation resistance.

Further evidence tended to show that strict comparisons could not be made, as there were no large underground haulages in Germany, and English mines are much more developed in that particular.

In running the cables down the side of the shaft they were clamped to battens, or swung, both in the shaft and headers, in the latter case from the roof.

The evidence as to the best type of cable to use was somewhat conflicting, Mr. Selby-Bigge considering that armoured cable stood the better chance in case of falls, until the suggested possibility of the armouring piercing the insulation under a fall of roof, &c., led him to modify his views, to the possibility of the unarmoured type being the best solution. He agreed that backwardness of English electrical manufactures was due to restricted scientific education and lack of enterprise. In regard to mining regulations, these were strictly enforced in Belgium.

THE INSTITUTION OF ELECTRICAL ENGINEERS IN ITALY.

(*Concluded from page* 687.)

The turbines at Paderno are controlled by hydraulic governors, as usual; the latter are provided with small motors by means of which the speed of each set can be regulated from the switchboard gallery, when synchronising or cutting out an alternator. There is little about the generators, switchgear and transmission line to show that they are working at the extra high pressure of 14,000 volts; but that they are capable of enduring a much higher pressure than this has been demonstrated by actual and crucial test. The line has been run at a maximum pressure of 22,000 volts, generated direct in the alternator, for some time without incident, the only novel phenomenon observed being the fluorescence of the micanite tubes which surround the conductors where they pass out of the building; this was attributed to the dampness of the evening air at the time. On another occasion, when the system was in normal working, a short circuit of the transmission line was caused by a falling tree. The main fuses blew at once, and as, for some reason, the governor was unable to act, the turbine ran away. The speed rose 70 per cent., and the pressure is believed to have reached 32,000 volts, though, as the step-down transformers of the voltmeters were burnt out, the exact value could not be ascertained. The frame of the machine became so highly charged with static electricity, we are told, that the driver was unable to shut down the turbine until the exciting current of the alternator had been reduced. In spite of the severe strain on the insulation, however, absolutely no damage was done to the generator.

The transmission line from Paderno to Milan lies across fairly level country, and Wurts lightning arresters at the termini are found to give sufficient protection; in crossing high ground, it would be necessary to protect the line with arresters at various points *en route*. The "horn" type of arrester is not regarded with favour, as the arc is sometimes persistent, and, even if it is broken, the violent discharge is apt to throw synchronous motors out of phase.

The line consists of 18 conductors, each a copper wire 9 mm. in diameter, carried by special porcelain insulators on a double row of iron lattice poles. The extreme subdivision of the mains was suggested by the late Prof. Ferraris, to avoid troubles with inductance and capacity, which, it was feared, would prove serious.

The wires are equilaterally spaced 60 cm. apart, with 2 m. between the rows of poles. Experiments made by Signor E. Vannotti, Messrs. Brown, Boveri's resident engineer, on a circuit looped at Milan showed that the capacity current at 16,500 volts, 42 cycles per second, was from 2½ to 3 amperes only.

With the outer terminals of one of the generators short-circuited, and the magnets excited to give the normal current, the voltage between the central point and the outers was found to be 3,000 volts. This, as is well known, is a simple way of measuring the voltage of the third harmonic, and its high value is attributed to the concentration of the armature winding in one hole per pole per phase; a distributed winding has been adopted in later designs. The point is interesting in view of the papers and discussions which have occupied the attention of the Institution recently.

During the visit of the party to the generating station, a memorial tablet of bronze was unveiled to the memory of Enrico Carli, the originator of the idea of utilising water power for the benefit of Lombardy, by the Edison Co., who translated the thought into act. Senator Colombo, chairman of the company, in a brief speech did honour to the genius of the engineer. Afterwards the visitors were photographed and entertained with light refreshments, before they drove to the railway station and returned to Milan.

In the evening, thanks mainly to the exertions of Mr. Robert Hammond and Mr. L. L. Robinson, a dance took place at the Grand Hotel di Milan, which was well attended, and, in spite of a superfluity of the male sex, was highly successful.

Wednesday, April 8th, was devoted to visits in and near Milan. The principal places of interest were the power station at Porta Volta, and the sub-station at Santa Radegonda. The latter is on the site of the original Edison central station, which began work in 1883; it is now used solely for converting three-phase current to direct current for lighting and traction.

The generating station at Porta Volta contains a large installation of Ganz transformers, representing a total capacity of 8,000 KW.; these reduce the pressure of the Paderno supply from 12,600 to 3,700 volts, for general distribution in parallel with the steam generating plant. The transformers are air-cooled. A large installation of Wurts lightning arresters is provided for the incoming overhead lines from Paderno.

The boilers are all of the water-tube type, by Signor Tosi and Messrs. Babcock & Wilcox, and are fired by hand with Welsh coal.

There are eight generating sets, of 13,100 H.P.; of these the most interesting are a Parsons turbine of 3,000 H.P., driving a Brown alternator, and a Parsons-Brown alternator of 4,500 H.P. The condensers belonging to these sets are of the jet type, the air pumps being driven by geared induction motors; all these, with the steam and exhaust pipes, are fixed in the basement. The steam consumption is only 14 lbs. per KW.-hour.

Important alterations of the switchboards are in progress. The new switchboard is of the cellular type—a novel feature in a Continental station. The connecting cables inside the works are single-core india-rubber-covered, lead-covered and armoured with brass tape, to avoid inductive troubles. Three-phase Pirelli cables, working at 3,700 volts, and aggregating over 100 miles, feed a network supplying 153 transforming sub-stations and kiosks, containing transformers of 11,600 KW. The supply pressure is 160 volts for lighting and power in parallel. Motors of a total capacity of 10,273 H.P. are connected to the three-phase mains, as well as 77,000 glow and 721 arc lamps. No trouble is experienced with the balancing of the load, for the simple reason that the motor load, which is necessarily always balanced, is so heavy in comparison with

the unbalanced lamp load, that the effect of the latter is quite swamped. This is a fortunate state of affairs, not to be looked for in a new undertaking. The load factor is 33 per cent.

The Santa Radegonda sub-station contains five motor-generators, of 500 KW. each, for the tramway service, seven of 250 KW. each for lighting and power, and two small ones. There are four Tudor batteries of 20,000 ampere-hours capacity in all, discharged in one hour, at 130 volts, and one of 3,800 ampere-hours at 550 volts; five 100-KW. Thury boosters are used in connection with these. There are no end cells, regulation being effected entirely by means of the boosters, which are controlled by the Magrini automatic system. One or more of the batteries is always connected with the switch-board. The lighting supply is on the three-wire system at 125 volts, and the maximum demand amounts to 2,000 KW. A 20,000-ampere watt-hour meter was an interesting feature. The traction battery "floats" on the line without a governor. The maximum demand for this service is 2,500 KW. The batteries are charged during the night, the routine being carefully organised so as to make the best possible use of the plant and power available; the total output of this large storage installation easily reaches 3,000 KW. at the peak load. The municipal tramways employ about 300 cars, and carry 75 million passengers per annum. The whole capacity of the complete plant at Paderno and Porta Volta is 28,000 H.P., there are motors of 18,819 H.P. at work, 174,095 glow lamps, and 2,227 arc lamps, and the maximum load is no less than 16,000 KW. There are also 390 cars running on 85 miles of track. These splendid figures abundantly testify to the immense benefit which has been derived by Milan and the surrounding district, from the electrical enterprise founded and developed by the Società Generale Italiana Edison di Elettricità.

Considerations of space prevent us from saying much at present about the other places visited. The Royal Technical Institute and the Telephone Exchange; Signori Pirelli & Co.'s electric cable works, where all sorts of rubber, gutta-percha and asbestos goods are also made; Signori Gadda & Co.'s electrical works, which are combined with those of Signori Brioschi Finzi & Co.; the car works of the Officine Mecchaniche; and Signori Riva Monneret & Co.'s turbine works—all were of interest, and attracted parties of visitors. We ought especially to mention a self-exciting compound-wound alternator under construction at Signori Gadda's works, and two single-phase commutating motors—the first an experiment, the second a practical traction motor, which was about to be tested on the municipal tramways. It is a singular fact that, while Mr. Lamme was experimenting in this direction in America, Dr. Finzi, in Milan, was engaged in a similar investigation, and, we understand, his efforts have been highly successful.

We must now pass on to what was, perhaps, the most enjoyable day of all—Thursday, the 9th ult. The party left Milan for Somma Lombarda by special electric train (provided by the Mediterranean Electric Co.) soon after 9 a.m. Next came a drive across country to the head works of the hydro-electric power station of the Società Lombarda per Distribuzione di Energia Elettrica. These were originally carried out by the Società Italiana per Condotte d'Acqua, for the supply of an irrigation canal, and consist of a weir 180 yards long, a set of sluices, and a forebay 374 yards long, from which both the irrigation and the power canals are fed. That the latter is also a navigable canal was most pleasantly demonstrated to the visitors; for, after inspecting the hydraulic works, they were conducted to a fleet of barges, decorated with coloured draperies and covered with awnings. On board these an attractive collation was provided, of which the guests partook while the flotilla gently glided with the current over the $3\frac{3}{4}$ miles to the power station. Whether it were due to the delightful and novel surroundings, the beautiful weather, the appetite engendered by the morning's proceedings (to say nothing of the very light "breakfast" in vogue abroad), the excellence of the repast, or a combination of these advantages, it is certain that the visitors were enthusiastic in their appreciation of the entertainment. Arrived at the Vizzola power house, the party was filled with admiration of the imposing array of machines, comprising 10 generating sets of 2,000 H.P. each, in one long row. The marvellous simplicity of a large water-power station is perhaps its most characteristic feature; certainly there is no motor in existence so simple and compact as the turbine, and it forms an ideal combination with the electric generator. The turbines at Vizzola were built by Messrs. Riva Monneret & Co., with the exception of two by Messrs. Voit, of Heidenheim; while the generators were supplied by Messrs. Schuckert & Co., of Nüremberg. The latter work at 11,000 volts, 50 cycles per second; they are of the braced-frame type, with stationary armatures, and all but three have magnet wheels of the single-coil interlaced-pole type. The armature winding occupies two holes per pole per phase. On the top of each machine is a "horn" lightning arrester, connected with the neutral point of the armature winding.

Ten three-phase primary lines leave the station, their length amounting to 87 miles in all; these feed the surrounding district at 11,000 volts, the pressure being reduced in 98 sub-stations, in which transformers of 15,500 KW. capacity are installed. There are 2,400 consumers, most of the mills in the neighbourhood having substituted electricity for steam. As the demand exceeds the supply, the company is preparing to utilise another fall on the Ticino, at Turbigo, where 6,000 H.P. is available; a steam-electrical station is also in course of erection at Castellanza of 6,000 H.P. There are 750 motors at work, and 15,000 lamps.

Returning to the railway, the visitors proceeded to Legnano, where they inspected the cotton mill of Messrs. Frua & Banfi, which is driven by motors of 2,700 KW. capacity, supplied from Vizzola; three of these are 700-H.P. induction motors. The engine works of Signor Franco Tosi were also inspected; here 1,500 hands are employed. Some large engines were in course of construction, and the various machines and processes were examined by the visitors with keen interest. Messrs. Tosi's engines are well known all over the world; 150 are turned out every year, with a corresponding number of boilers.

This was the last of the official visits of the Institution; there remains only to chronicle the dinner given that evening by the Associazione Elettrotecnica Italiana, in honour of the visitors, at the Savini Restaurant. Needless to say, the entertainment was of the most luxurious and enjoyable. After the meal, Signor Askele, President of the Association at Rome, addressed the assembly in English, referring to the honour conferred upon Italy by the visit, and expressing the hope that Italian and British engineers would become more intimate in the future. Mr. R. Kaye Gray, our President, thanked the last speaker for his kind words, and expressed the warmth of our feelings towards his nation—which was none the less after the lavish hospitality displayed toward us. Col. Crompton proposed the health of the Electro-Technical Association, coupled with the name of its President, and Prof. Silvanus Thompson delivered a speech in Italian. Mr. S. Z. de Ferranti added a tribute of appreciation of the magnificent works which we had seen, and the still finer reception which our Italian *confrères* had given us. Mr. Ferranti, it may be noted, occupies a position *vis-à-vis* the Italians somewhat similar to that of Mr. C. E. L. Brown towards ourselves. Mr. Gavey spoke in French, cordially endorsing the prevailing sentiment of appreciation. Signor Semenza, speaking in English, said that he was an Italian born in England, and that the pleasant words which he had heard gave rise to resonance in all the best harmonics of his heart. The sea, which surrounded their coasts as ours, and generally separated nations, here united them.

Later, to mark the visitors' admiration of Signor Semenza's indefatigable efforts in organising the tour, and their appreciation of his high personal qualities, the President presented him with a gold cigarette-case and a silver cigar-box, subscribed for by the members, the presentation being applauded with acclamation.

Signor Kossuth expressed the pleasure derived by the railway companies from the visit, promised the King a hearty welcome (which we know has been most amply fulfilled) and said "Come again soon!"

Mr. C. A. Baker addressed Signor Semenza in Italian, expressing the gratitude of the visitors for the work of organisation which he had done so well, and for the admirable programme which he had written in English and Italian, and assuring him of the lasting personal friendship of the British engineers.

With this the official programme came to an end. On the following day (Good Friday) the party broke up; some

returned home, a large number proceeded to Venice, others sought rest and recreation in various directions. But all carried away the same impression—that the tour had been an unqualified success.

It is right to add that the success was due mainly to Senator Colombo, chairman of the Edison Co.; Signor Bertini, President of the Milan Electro-technical Association; Signor Semenza, secretary of the Association in Milan; and last, but not least, to Mr. W. G. McMillan, secretary of the I.E.E., and his assistants.

CORRESPONDENCE.

Some Experiments with an Extra High-Tension Fuse.

Mr. Eborall, in his letter in the April 17th issue of the ELECTRICAL REVIEW, criticises my article which appeared in the issue for April 10th under the above title. Mr. Eborall's objections to the value of the tests made are:—(1) The fuse was new; (2) blown by a current of low power factor; (3) certain other conditions which the fuse would be called upon to meet under running conditions are much more severe.

The question being one of fuse *versus* automatic switch, the three objections must be considered in this light. To begin with, I do not see where the inherent objection to the use of an E.H.T. oil-break fuse comes in. The duty it has to perform is exactly the same as that of an automatic switch, viz., an arc is formed between metallic contacts which is damped out by the oil. The only difference is that in the case of the fuse the arc has to be started just outside the oil instead of under the surface. But with proper design this can be allowed for, and if a fuse fails in its action it must be due to some fault in its design. It would be better, I think, to endeavour to eliminate any such defects which may exist than to shut out the use of fuses altogether.

The only way that a fuse can deteriorate with time is by the fuse wires becoming weakened and thus allowing it to open at a lower current, or its mechanism may become choked up, or the whole thing get so dirty that there is a conducting path between the contacts. These points, with the exception of the first, which, *per se*, cannot modify the action of the apparatus in opening circuit, apply with increased force to the automatic circuit breaker, inasmuch as this contains more mechanism and moving parts than the fuse. The continuous-current tripping mechanism necessary with the switch is also liable to refuse to work when it has not been called upon to act for several months. I think, therefore, Mr. Eborall's first point is rather in favour of the fuse than otherwise.

As regards point No. 2, although the power factor may be low, yet there is evidence that there was a very considerable power expended in the blowing of the fuse. Fig. 1 gives a record which was taken on the tachograph attached to the alternator during one of the shorts. It will be seen that before the switch was closed the machine was running at normal speed. Directly the switch was shut the alternator was pulled up and the speed gradually lessened until the circuit was opened by the fuse blowing. The speed immediately ran up above the normal till brought back by the governor. The total diminution of speed amounted to 1·8 per cent. The magnet wheel of the alternator weighs 88 tons, with a radius of gyration of 11 ft. 6 in. (not having a scalable drawing to hand I have assumed this value for the radius of gyration; I do not, however, think it is far out). Running at 75 revolutions, the wheel has stored up in it 25,130,000 ft. lbs. of energy. Running at $75 \times \frac{98{\cdot}2}{100}$ revolutions, it has 24,235,000 ft. lbs.; the difference, 895,000 ft. lbs., is given out in 1·35 seconds, which is the time taken by the fuse to blow. This corresponds to a mean power of 1,202 H.P. going into the fuse; the actual power is, of course, considerably larger than this, as I have not reckoned that given by the steam, but simply that got by pulling up the fly-wheel. Standing near the engine at the time of the tests, it was easy to tell that considerable load was thrown on to it every time a fuse was blown.

Referring to Mr. Eborall's third point, and also to his remarks as to the proper way to test fuses, I venture to think that Mr. Eborall overlooks one important consideration—namely, that in judging of the capabilities of a fuse (and, for the matter of that, of a switch also) the first and most important criterion is its capability of safely dissipating the great amount of energy which is suddenly thrust into it at the instant of its action. If this energy is liberated in a too confined space, the oil is excessively heated, so that it fires and does not extinguish the arc. In testing a fuse, therefore, the primary object to be sought after is that the fuse shall be called upon to dissipate a very large amount of energy when it blows. In the tests which I described this was the case, and they were therefore severe and reliable. The test proposed by Mr. Eborall of throwing two machines into parallel at normal pressure when they are in opposition of phase is, of course, a very good one. It differs from the ones I was able to carry out, in that a stress pressure of double the working pressure comes intermittently across the terminals of the fuse. This pressure is, however, only on for such short periods of time that, if the insulation between contacts be at all good for the working pressure, it will be quite safe for this. I do not think the energy liberated in the fuse will be any greater in this test than in the method adopted by me; the test, therefore, would not be more severe. We must not forget, too, that if at one

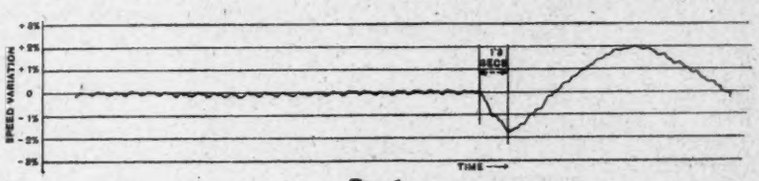


FIG. 1.

instant the stress pressure across contacts is double the working pressure, the next instant the pressure will be equal to zero, as the two generators never remain absolutely out of phase, but swing backwards and forwards into phase, and then into direct opposition of phase, and then back again. At the instant of zero pressure, any arc, of course, would tend to go out of itself. The current through the fuse under this test would also be of low power factor.

The severer test which Mr. Eborall says would be made by paralleling a large synchronous motor at the end of a long cable line when the motor and supply E.M.F. waves are in opposition of phase, arises, I presume, from surges of current or rises of E.M.F. which would be set up in the cable by the circuit opening. It has, however, yet to be proved, that if the circuit be opened by an oil-break switch or fuse, these surges or potential rises are set up. On the contrary, what experimental evidence we have rather tends to show that it is only when open-air arcing switches are used on such lines that this occurs. The question, therefore, reduces itself down to the energy thrust into the fuse, and under no circumstances would this be greater with a motor at the end of a cable line than in the tests I made.

Taking all things together, therefore, I think I was justified in saying that the tests made prove that it is "possible to construct a fuse to open a 10,000-volt circuit (with a large amount of power behind it) under all conditions with certainty and safety." I believe that experience with the fuse described under running conditions on an 11,500-volt circuit will, when obtained, bear this out.

C. C. Garrard.

Electric Ignition in Gas Motors.

In reference to the excellent article on "Electric Ignition in Gas Motors," by Sir David Salomons, which recently appeared in the ELECTRICAL REVIEW, may I point out a few more facts concerning the lead-covered cable recommended by him for the connection of the various parts of the high-tension circuit.

In the first place, I would say that the combination of a condenser capacity (in any form) with a sparking plug and high-tension generating circuit as a means of firing the

charges of internal combustion engines forms the subject of a patent taken out by me some two years since (No. 9,770 of 1901), and that a piece of metallic-covered cable is one of the specific methods therein described of forming the said condenser for the purpose. Secondly, however, I would point out that a condenser formed in this way has some curious properties which render it both extremely dangerous and a source of unreliability in working, unless its effects are fully understood and constantly guarded against. Sir David Salomons leaves unmentioned a very important item—viz., to obtain the condenser effect the outside metallic covering of the cable must be joined to one side of the plug and coil high-tension circuit *viâ* the "mass" or frame of the machine, so that the inner conductor connecting the other side of the coil and plug shall form the second plate of the condenser. If this earth connection is omitted, not properly made, or at any time becomes broken, the conditions of the Fulham electrocution case are exactly reproduced, and anyone catching hold of the outside lead covering while standing on damp ground (as they are very likely to do) will get a shock sufficient to cause serious bodily harm, and, in fact, if the constitution be delicate, and the accumulator and coil be in good order, it may even be sufficient to kill. Those who have taken a shock by merely touching the high tension terminal of a plug or coil while the trembler is running know what a very unpleasant experience it is, but with this condenser action the consequences are enormously increased. The phenomenon of resonance comes in, and the electromotive force of some 30,000 volts generated by the coil (capable of producing a full ¼ in. spark in air) is backed up by a comparatively large current from the condenser. Much more energy is now put into the spark (as is proved by the enormous observable increase when the proper condenser is applied). When the human body is substituted for the spark gap, therefore, this increased energy necessarily expends itself in a very disastrous way.

Added to this is the fact that the lead covering of the cable forms an excellent handle or electrode to convey the current into the body when grasped, and, moreover, as at Fulham, looks such an innocent ordinary piece of pipe that the devilish powers of its surface are entirely unsuspected. Even when the lead covering is properly connected to the frame, a considerable shock is frequently obtained from it, and from every part of the frame when touched while standing on moist ground with the trembler running, owing to the partial insulating effect of the pneumatic or rubber tires usually fitted to the cars.

There is also another effect of metallic-covered cable used in this way which would be scarcely credited until demonstrated by trial, and which forms an ever present danger—viz., that if the said metallic covering be touched up against, or vibrated on and off of any part of the frame of the machine, a spark is there produced at every point of contact, notwithstanding that the said covering may be well connected by wire to the frame at a point perhaps close by.

The violent impetuous oscillatory currents, in fact, cause the lead-covered wire to become a veritable fiery serpent, sparking at all and every point into every bit of metal with which it may come into contact, or which may come into contact with it. This may be easily proved by touching it anywhere while the trembler is running with any piece of tube or metal whatever, either earthed or insulated.

An accumulation of petrol vapour of the requisite strength, therefore, is all that is required with this to produce the inevitable result, and another "mysterious" explosion be duly reported.

Moreover, although a certain amount of condenser capacity is good for the spark, it is very easy to be overdone, with the result that, should the battery get the least bit weak, no spark at all is produced, the whole of the alternating current being swallowed up by the capacity, so that if metallic-covered cable is used as a condenser, an exact length is required, depending on and varying with the gauge of wire, the kind and thickness of dielectric, the E.M.F. of the battery, and the kind of coil used, to obtain the proper effect, while the length actually required for connecting the parts is usually quite a different thing altogether, and such circuit may cause miss-fires, or even sometimes prevent the spark occurring at all.

For many reasons, therefore, although the use of a metallic covered cable in this combination is a part of my patent's claims, I think motorists will do well to avoid its use and employ the definite condensers properly adapted to the circumstances of the case, and which are now put on the market by Messrs. Peto & Radford, of Hatton Garden, bearing in mind also that, although an even larger spark can frequently be obtained for a time by increasing the capacity, that given by these condensers is the very best spark that can be safely relied upon to *last*. If further increased, it would be in constant danger of stopping altogether.

This apparatus was exhibited working at the recent Automobile Show, and Sir D. Salomons was, I believe, amongst those who saw it and were interested therein.

The high tension condenser, when properly made and adapted to its conditions, is a great improvement, but, like many other things, it becomes a source of trouble, or even of danger, unless it is so constructed.

A. C. Brown.

London, *April 23rd*, 1903.

[Our correspondent's remarks on the awful dangers of the ignition coil will lead those of our readers who do not "motor" to congratulate themselves on their immunity from such perils. Hitherto we had supposed that the harmless pedestrian had most to fear, but it is now clear that the driver, or the "shover," must have heroic qualities.

We pass by the question whether it is possible to obtain a valid patent for the use of capacity in combination with a sparking plug circuit, though no such circuit ever was made, or could be made, without possessing capacity. We feel bound to express the opinion, however, that our correspondent's views on the magnitude of the capacity of a lead-sheathed conductor, on the danger entailed by the use of the latter, and on the occurrence of resonance, are, as Mark Twain said of the announcement of his death, "grossly exaggerated."—Eds. Elec. Rev.]

Electrical Micrometry.

Can any of your readers help us in a difficulty we have encountered in wandering down the byways of the commercial application of electricity?

We cut or punch a very large number of die-like articles in brass. The total area of the punched surface is about $\frac{1}{16}$th in. square, and the depth about ·035 in. The deepest portion of the die is practically a hair-line, or sometimes a point, and is a trifle under ·001 in. wide.

We make millions of these articles, a large proportion of which have to be measured as to the depth. The limit of error allowed is ± ·00025 in.

Many methods have been tried, and practical factory use eliminated all except the employment of a needle point, a micrometer screw (with a hair spring to prevent damaging the needle), and a buzzer, which is practically a small domestic bell without the striker and gong.

This rig has been in use for some years, and is satisfactory, except that the needle point burns away so fast as to require the re-setting of the comparator every day, a tiresome job to do when there are 30 or 40 in use.

We use a single dry cell, and fairly ancient at that, but the spark made at breaking causes the trouble complained of.

In an endeavour to get rid of the spark, which is aggravated by the coil of the buzzer, I made a small alternator which runs at a periodicity of 400 per second, and carried leads to the comparators, substituting watch receiver telephones for the buzzer.

This proved entirely successful in preventing the burning of the needle points, which last two or three weeks, *but* the current from the alternator is so slight and so choked down by the essentially high ~ that it is almost necessary to use a receiver at each ear to hear the *thump* when contact is made.

The operator requires the use of both his hands when measuring, and other circumstances prevent the adoption of a telephone helmet, consequently we are endeavouring to find a relay that will work a needle—such as a galvo—or the aforementioned buzzer.

The current used is so small and so severely choked, that

it will not make the slightest kick on any instrument we have, and if we reduce the ~ and insert an ordinary relay, it is quite natural that our old bogey the spark will again appear.

This extremely minute application of *juice* will interest but few; should any of your readers see a way to overcome our trouble, I hope he will set down his ideas in this column.

W. A. T.

April 24th, 1903.

[We would suggest the use of a non-inductive resistance shunt, or a small condenser, across the contacts, in conjunction with a telephonic buzzer or a delicate galvanometer.—EDS. ELEC. REV.]

Municipal Loans.

I cannot understand the position you take up with regard to municipal loans. Why should a corporation set aside such a sum of money every year that at the end of 20 or 25 years they should have a complete up-to-date plant and no debt? Such a condition of affairs practically means that the people of that town have been taxing themselves heavily in order that the next generation may have cheap electricity, for it certainly could not be cheap while they were required to pay such a large percentage as would be necessary to wipe off the debt and buy new plant.

It seems quite clear to me that all that is necessary is to set aside a sum—call it a sinking fund or a depreciation fund—sufficient to pay off the loan by the time the plant requires renewal, and then raise another for that purpose. If over and above that sum the corporation "saved up" an amount large enough to renew the plant without borrowing, it is clear that, presuming the rates were not to be called upon, the electricity would have to be sold at a higher price during the first 20 or 25 years of the existence of the undertaking; in other words, the community would be taxed in order that their successors might be spared the necessity of paying interest on the money which had to be borrowed to form the capital of their undertaking. This I consider eminently unfair. You say that to borrow fresh capital every 20 years is a financially unsound method of conducting the business. If a man has a marketable commodity, he would be very glad if he could borrow capital, commence business and make enough profit out of it to wipe off the debt in 20 years and, supposing his plant required renewal, commence again in the same way. He might, as you say, save also enough to wipe off the debt and renew the plant, and so commence with capital of his own. He would have to practice abstinence, which is one of the foundations of wealth, and this would be good business in the individual, for he would reap an increased income in his later years, but a community has no call to tax itself for the benefit of posterity. They might just as well save up money and relieve the rates with the interest, even if they have no municipal "enterprises" on hand.

H. C. Gunson.

Manchester, *April 25th*, 1903.

[We regret that our correspondent cannot understand our position; we have repeatedly stated it. He approves sound business methods in the case of the individual, but declares that a municipality need not practise them! This selfish view—that posterity must look out for itself—is fundamentally immoral, and if persisted in will lead to disastrous results, as it undoubtedly would in the case of individuals. By undertaking the supply of electricity under statutory powers, the community incurs and hands on to posterity an obligation; it is morally bound to provide the means to carry out that obligation, without binding the hands of its successors by bequeathing to them a burden of debt. As we have shown repeatedly, and as our correspondent admits, that burden is eternal—unless our counsel is followed. That electricity cannot be cheap while the undertaking is being placed on a sound basis, is obvious; what we complain of is that the municipalities, instead of recognising this fact, persist in exhibiting unreal profits, and even pay sums to the rates, which will one day have to be refunded.—EDS. ELEC. REV.]

I understand from your replies to my letter that you at last concede that the sinking fund can act indirectly as a depreciation fund, inasmuch as it makes it possible to renew plant out of a fresh loan, which, were it not for the sinking fund, could not be done; but, having got as far as this, you must proceed to say that such a policy is unsound, because it would perpetuate a loan the size of which would be somewhere proportional to the size of the undertaking, which the undertaking would always have to bear.

The whole point is this: Assuming an undertaking has a 3 per cent. surplus, this 3 per cent. can either be added to the sinking fund annually, so that at the end of 25 years the loan is not only extinguished, but a further sum equal to the original loan has been raised with which to renew the plant, or else it can go into the ratepayers' pockets, and the plant be renewed, when necessary, out of a fresh loan. In the first case, the present ratepayers are mulcted to the extent of 3 per cent. annually, so that the next generation may see a 3 per cent. profit for themselves on this sum raised. In the second case, each generation of ratepayers will not bear more than their fair share of the liabilities of the undertaking, and will not be benefiting at the expense of former ratepayers' pockets. This, I must say, I have always considered the only just way.

I contend that one way is no more unsound than the other, because whatever capital the undertaking is working with, either borrowed or subscribed at the expense of the present ratepayers, as you suggest it should be, it is morally bound to pay 3 per cent. interest on such capital, for if subscribed capital is not going to show at least an interest of 3 per cent. annually, it is unsound business to subscribe it. The undertaking is no more unsound for having to pay 3 per cent. on borrowed capital, than it would be if it paid 3 per cent. on subscribed capital.

You have made a statement that renewing plant out of a new loan, after the original loan is paid off, under the operation of the sinking fund, is unsound. I do not see after what I have just said, upon what grounds you can possibly uphold it.

David Smith.

London, *April 27th*, 1903.

[The sinking fund in no way acts as a depreciation fund; it is used for repayment of borrowed capital, and nothing else. We repeat that perpetual and increasing debt is unsound business. We object to playing off the pockets of the present ratepayers against those of their successors; the community is a continuous entity, not a succession, and its interests to-day are its interests next year or 20 years hence.

Perhaps a parable would help our correspondents to see what they will not willingly see:—

There are two ways of protecting low-lying ground against the effect of floods. One is to gradually pump out the water every time the river overflows its banks, completing the operation about the time the next flood comes along. The other is to build up the banks so that the flood doesn't take place. The land is then left free for profitable utilisation. The former is a spendthrift way, the latter the way of the prudent husbandman. We submit this view of the flood of municipal indebtedness to the consideration of our correspondents: the fertile land is the credit of the community, and the protecting dyke is the depreciation fund. The credit of a nation is bound up with that of its component parts, and we cannot view the ever-increasing flood of municipal debt without alarm—yet many seem to look upon it as no great matter; they even rather like it! Lastly, we fail to see why "the present ratepayers" should claim a profit of 3 per cent. on capital which does not belong to them.—EDS. ELEC. REV.]

On Coherence.

I must apologise for again trespassing on your valuable space in replying to "W. P. B.," who still upholds his expansion theory. How does his theory apply to metals not affected by a magnetic field, in the sense in which he uses the term "magnetic"? Nickel, silver and gold (viz., the Blondel coherer mentioned in the current issue of your paper), all act as coherers; the first metal is only slightly magnetic, the last two not at all or diamagnetic.

O. D. L.

A New Application of Electricity.

I have often noticed the crude methods adopted in various parts of the country in contracting brass liners on a ship's propeller shaft. Could not this be accomplished by A.C. inductively—by a three-pole magnet or protected movable primary coil or similar means?

I know of several establishments where an available 300-KW., 130-volt ~ 10 is to hand. (Bipolar continuous current dynamo converted.)

Would this be enough for the purpose? If this system could be applied with success it would prove a great boon to many engaged in this class of work, as it would save an enormous amount of trouble and time. I may state that some of these liners attain proportions of about 20 ft. × 16 in. diameter × ⅞ in. thickness.

Inspector.

Consulting Engineers.

I have read with much interest your leading article on Mr. George Westinghouse's ideas as to consulting engineers and can readily appreciate his point of view. At the same time there are some points raised in your article which ought not, I think, to pass without comment. The whole question is a very simple one, and is readily reduced to first principles. In all trade transactions there are two parties, one, the purchaser who is buying, and the other, the contractor who is selling. Their objects are exactly opposite, those of the former being to buy the best article at the cheapest price, and those of the latter to sell his wares for as much as he can get for them. If the purchaser always knew the value and quality of the articles he was buying, all would be well, and the two parties might be left to make their own bargain, but, as a rule, he does not, and therefore he requires someone who does, to look over his shoulder and advise him. In engineering matters this person takes the form, either of an engineer permanently employed or of a consulting engineer called in for the purpose. An engineer having sufficient ability to advise in this way commands a high salary, and so in many cases, it is not profitable permanently to employ him, and it is better business to retain the services of a consulting engineer and pay him only while the job is in progress, the expense ceasing when the work is completed.

No one would suggest that there are not many large contracting firms who, if left to themselves, are capable of successfully devising and carrying out the work; such a contention would be foolish. On the other hand, the contracting firm, necessarily, has in its eye the price it is obtaining for the articles sold, and, if it is wise, quotes according to circumstances.

In your article you advocate that in smaller schemes firms who are adopting electric power would best study their interests if they set aside the consulting engineer, and asked a limited number of contractors to submit schemes and recommendations, and then selected the one that seemed most suitable. I have a good deal to do with schemes managed in this way, and my invariable experience has been that, as there is no common basis or standard, and each contractor tenders for something different, the private firms get into a hopeless tangle, and are quite unable to judge what is to be sold to them, or to compare the prices with any fairness. The general result has been that they have had to call in a consulting engineer to sift the tenders and advise them which to accept. If they trust to their own judgment, and accept "what seems most suitable," they frequently find themselves with something they do not want—a large bill for extras—and are generally hopelessly bled into the bargain. There are, of course, many firms who will conscientiously tender for the best they have to give, and at a reasonable price; but there are others who will supply anything so long as it will work—they all look the same in the tender—and what chance do the good firms stand as regards price when compared with the indifferent ones, unless there is someone behind the buyers who is able to discriminate between them?

Looking at the question from another point of view, any installation of machinery is a carefully thought-out combination of machinery and buildings, the machinery as a whole being composed of different machines, each probably the standard design of different makers. The secret of buying this machinery cheaply is to buy it individually, each machine from its own maker, and it is a matter of indifference to the buying firms in what way the details of their machinery are arranged, or where it comes from, provided that, as a whole, it is in all respects as capable of performing the work required of it at least as economically and efficiently as that made or supplied by one of the well-known firms. There are hundreds of firms through the country, some large and some small, all making the same class of article, and, though it may not suit the large contracting firms, the consulting engineer who knows his business, and what is the same thing, his markets, obtains the experience of the contractors, and can place his clients' orders for the individual machines amongst the makers of each class to a very much better advantage as regards price than if they were all supplied by "a well-known firm" under one contract.

The consulting engineer must, of course, be a reasonable person, without idiosyncrasies, and with a fair and open mind, and he must confine his purchases as much as possible to standard articles. To my mind, it is the very fact that firms are making specialities of different classes of machinery, some pumps, some condensers, some engines—machinery that used, in the old days, to be all made by a firm of general engineers—that makes the employment of a consulting engineer to scheme out, collect together, and instal the various standard parts which go to make up the whole, more necessary now than it was, when all the component parts of an installation were made by one firm of general contractors.

Hal Williams,

60, Queen Victoria Street, E.C.
April 24th, 1903.

[Our correspondent writes an admirable letter, with much of which we agree. By a slip in our article we said a certain course was "the most" advantageous, where we should have said "the more," *i.e.*, of the two cases considered; we then went on to point out a better still—viz., to procure complete tenders from competing firms, and to submit them to a consulting engineer for judgment. Given a consulting engineer who is "a reasonable person, without idiosyncrasies," &c.—why, engage him to carry the whole thing through.—Eds. Elec. Rev.]

PARLIAMENTARY.

The City and North-East Suburban Electric Railway Bill.

The hearing of this Bill was resumed by Mr. Compton Reckitt's Select Committee of the House of Commons on 22nd ult., after the Easter Recess. Further local evidence was called.

Mr. Dunford, an architect and surveyor, and a member of the Walthamstow Urban District Council, gave evidence as to the overcrowding on the Great Eastern, and the necessity of the proposed line. He read correspondence which had passed between his Council and the Great Eastern Co., which, he contended, showed that the Great Eastern had done all that it possibly could towards relieving the congestion. His Council wished to encourage a better class to take up residence at Walthamstow. There was plenty of land which could be developed into better-class residential localities. With regard to the question of cheap workmen's fares, witness said in reply to Mr. Pollock, K.C., for the London County Council, that his Council would be quite satisfied with the issuing of workmen's tickets from Walthamstow to the City for 2d. Personally, he would like to see the cheap fares extended further towards Epping Forest, so as better to distribute the working classes along the line. The proposed line would have an additional value, inasmuch as it would carry people on such days as Bank Holidays as far as High Beech, whereas the Great Eastern carried them only so far as Chingford.

Mr. Wm. Houghton, an auctioneer and estate agent and a resident at Woodford, called on behalf of the promoters, said that the district most suitable for building development was that north of Walthamstow and south of Chingford.

Mr. Roddick, a land agent, said that he had the management of over 3,000 acres at Chingford Green and Waltham Abbey. In his opinion more railway communication was needed, not only for the development of the estates, but also for the existing population. There was no land owner opposing the Bill. In reply to the chairman, witness said that the marsh land in the district had to a great extent been utilised by waterworks, and there was certainly 7,000 acres between Waltham Abbey and Forest Road which would be available for building purposes, and would not in any way be subject to any geographical disturbance due to the existence of underground water.

Mr. Balfour Browne, K.C., for the promoters, said that he did not propose to call any further local evidence, but he wished to

put in resolutions in favour of the Bill from the Urban District Councils of Chingford, Southgate and Edmonton. He would now call the engineering evidence.

Sir Douglas Fox, the head of the firm of Sir Douglas Fox and Sons, the engineers to the scheme, was then called, and stated that he had been engineer to a large number of electric railways. The proposed routes were, generally speaking, before the Joint Committee, and the west route was passed by Lord Windsor's Committee. The Joint Committee had recommended that tubes should follow the routes of the main roads as far as possible. The proposed line would be underneath the main road from the Monument to Hackney Road. The line would pass through some of the most populous districts of the metropolis, and would connect with certain tramway systems, and also with a light railway already sanctioned from Seven Sisters Road to Woodford, which the Walthamstow District Council were constructing. The Bill, as it stood in 1902, proposed to branch off at Stamford Hill to Walthamstow. The promoters were not the same. Walthamstow would now be served by the eastern line passing through Victoria Park to Walthamstow. That part of the line which passed through the City itself would cost more than a million, and the suggestion of the Joint Committee to avoid a confluent junction by having two routes into the City would be most expensive, as the line would have to pass under very valuable private property. At Liverpool Street the promoters had an arrangement with the Central London, that, should the proposed extension of the latter line be carried out, there would be an exchange station between the two lines. In answer to the Chairman, there would be a 2½-minutes' service from Monument to Hackney Road, and from there the service would be a 5-minute service to Chequer's Green on the one branch and to Waltham Abbey on the other. The trains would be worked on the multiple-motor system. At the terminus at the Monument there would be a cross-over, but the trains would arrive at and depart from the same platforms. One of the advantages of the multiple motor system was that there was no locomotive to be shunted from one end of the train to the other. At Liverpool Street they proposed to connect with the Great Eastern by means of a subway, should the Great Eastern Co. agree. He considered the station at Threadneedle Street to be most necessary, as it was desirable to break up the traffic into the City at various points. They had scheduled land at Threadneedle Street and the Monument under which they could construct their station. He considered, however, that they would be able to get the consent of the Corporation to construct the stations under the roads. Such a station had been made at the Bank by the Central London. At Hackney Road and Shoreditch they were putting the stations under the roads at the express wish of the local authority. In reply to the Chairman, there was a precedent for the construction of a junction; he would not call it a confluent junction, for it was nothing of the kind, at Hackney Road. On the Charing Cross and Euston line, of which he was the engineer, there was a similar junction now in course of construction at the Mother Red Cap, Camden Town. He exhibited a model of the junction at Hackney Road, and explained that should a driver ignore the signals the brake would be put on by means of an automatic arrangement, and the train would be shunted into a siding if the driver attempted to proceed. With regard to the speed of the trains, Sir Douglas said, in reply to the Chairman, that they would be quite willing to insert a clause in the Bill that they would not run the trains any quicker than a 2½ minutes' service, without the consent of the Board of Trade. The cost of the railway per mile would be for the whole line £272,728, the tube portion being estimated at £967,134 [?] and the open portion only £47,500. The cost in the City would be greater than in other portions on account of the cost of the sites of the stations. The cost already mentioned was only for the construction of the tube and lines, the generating stations, &c., would of course increase the cost per mile. The total cost of the overground line, including the generating stations, &c., would be £125,000 per mile for the Tottenham line and £140,000 for the Waltham Abbey line. It was intended to give workmen's tickets early in the morning to workmen going north as well as those travelling to the City. There would be a generating station at Temple Mills. The greatest curve on the proposed line was 7 chains and the greatest gradient 1 in 50. Questioned by the Chairman, Witness said that the tubes would be 12 ft. 6 in., which would enable them to put in a good firm permanent way. This decreased the vibration very much. The depth of the rails would be 5½ in. The cost of tubes had been found to increase as the square of the diameter less 10 per cent. The line would be worked by trains consisting of eight carriages, four motor carriages and four "dummys," which would enable them to break the trains up on the less used part of the line. The motors would be covered with steel plates to prevent sparking. The tunnels and stations would be lit by electric light supplied from a source independent of the motive power. The signalman would be able to light up at will the adjoining portion of his tunnel. This would be available should a train, say, fail to make its appearance and also in the case of repairs to the line.

On 23rd ult. Sir Douglas Fox continued his evidence, and said that if they adopted 11 ft. 6 in. tunnels instead of 12 ft. 6 in., it would make a decrease on the cost of the line of £136,000 per mile. It was left to the Board of Trade to decide what the size of the tunnels should be. The stations were very frequent, and that increased the cost of the line.

In reply to a question by the Chairman, Witness said that he had no doubt that the various steam railways around London would in the future be worked electrically, so that inter-communication between the existing lines and the various proposed electrical lines would be able to be made. During the night this line would, on that part north of Leyton, be available for goods traffic. If the goods traffic became important enough, no doubt arrangements could be made with the Great Eastern for a connection with their main line. From the end of the Tube at Leyton to the City the line would be exclusively for passengers. The proposal with regard to the Monument station was to place the shafts under the street providing the Corporation agreed to that.

Sir Ralph Littler (for the Corporation): But the Corporation won't agree to stations under the street.

Continuing, Witness said that there would be four staircases besides the lifts. The stations would be 65 ft. below the surface of the street. The crown of the arch would be about 53 ft. below the surface. Should the Corporation refuse to allow them to put the shafts under the street, they would place the shafts under certain property which they would acquire beside the street. There was a parallel case for the construction of such shafts under the street in the case of the Great Northern and City Railway Act, of 1902, in their extension to Lothbury. It would be more convenient to the public to have the shafts under the street, for there would in that case be seven entrances, whereas if they had the shafts on their own land, there would be only two entrances.

The Chairman: Are you prepared to give the Corporation the sole right to prescribe where the entrances and exits shall be?—Yes, certainly.

With regard to the demand of the Corporation that the company should deposit the sum of £20,000 with the Corporation, Witness said that they were quite willing to do that. The deposit was to ensure that the works under the street should not be commenced and left unfinished. At the Monument station they had arranged so that the sewers would not in any way be touched. At Threadneedle Street station they again put themselves into the hands of the Corporation to control the exact position of the access. The proposal was to put the station under the triangle, and have the accesses on property which they had scheduled should the Corporation not agree to their making the accesses at the sides of the triangle in the public street. They preferred, however, to have the entrances in the street, but were prepared to purchase certain property, though the cost would be great, for the construction of the shafts. This property they desired to be empowered compulsorily to purchase from the owners. Certain banks opposed the construction of the station at this spot. Plans were shown of the station at Liverpool Street, and witness explained that they proposed to take certain property on the west of Liverpool Street. There would be a connection by means of a subway with the existing subway between the Metropolitan and the Great Eastern.

Mr. Pember, K.C., on behalf of the Great Eastern Railway Co., remarked that he should oppose that plan.

Sir Douglas Fox, continuing, said that the proposed subway would be a great convenience, not only to the public, but also to the Great Eastern, for it would place that railway in direct communication with South London. There would be four lifts at Liverpool Street.

In reply to the Chairman: There would be six lifts at the Monument station. The estimate of the total cost of construction was £4,217,053. The permanent way and station buildings were estimated at £2,956,395; generating station, rolling-stock, lifts, &c., £1,300,000; compensation for land, £1,070,632. There would be a track between the rails on which passengers could walk should any breakdown occur. The sleepers would be of non-flammable wood.

The Chairman asked if the proposed plan to be adopted in the construction of the permanent way with the object of lessening vibration had been tried on any other railway. Sir Douglas said that it had not; but in any case it would be adopted for reasons other than the prevention of vibration.

Questioned as to the advantages of tubes compared with shallow tramways, Witness said that the cost of shallow tramways would be very great under city streets. Of course, in regard to those now in course of construction by the London County Council the case was different, for the streets were new also. In New York the authorities had had great trouble with the shallow tramways.

Cross-examined by Sir R. Littler: The reason for taking the line as far as Chequer's Green was that at that place they would acquire lands for the construction of workshops and car sheds. Possibly the land immediately north of Tottenham was not suitable for residential purposes. The capacity of the trains would be 450 persons per train of eight carriages. The cost of construction was about the same as that estimated for last year's scheme. The increase in the total cost was owing to the extra cost of land.

By Mr. Pollock, K.C. (for the London County Council): The surface at Victoria Park was not touched by the line. At the playing fields, Hackney Marshes, the railway passed over the fields on an embankment 17 ft. high. They proposed to give the public a piece of land in place of that to be taken away. The amount of land to be given in return was slightly larger than that to be taken. With regard to the generating station near the playing fields, there were no buildings near which could suffer from vibration. Witness was aware that the London County Council were constructing two main sewers to Barking, but he understood that the sewers would be far above the level of the line.

On 23rd ult., in the temporary absence of Sir Douglas Fox, the first witness called was

Col. York, Chief Inspecting Officer of Railways to the Board of Trade. Witness said that hitherto no maximum for the diameter of tubes had been fixed, but he thought that a minimum and a maximum should be fixed. His view was that the minimum should be 13 ft. 6 in. That allowed a pathway to be made at the side of the line, so that passengers could get out in case of a breakdown. The size of such a footway depended on the size of the rolling stock and the tunnels. The conductor rail should also be of a standardised size.

The Chairman: Suppose there were no question of a confluent junction now, what would be your personal opinion on such a junction?—Well, some years ago I expressed an opinion against

such junctions; but if the junction is beyond the station, and an arrangement is made whereby it is impossible for a train to pass into the station while another is there on the same line, I can see no objection to such a junction.

Cross-examined by Sir R. Littler: He would avoid junctions when possible.

In reply to Mr. Pember: He believed that he said before the Royal Commission that 13 ft. 6 in. was the more desirable size for tubes.

Cross-examined by Mr. Coward (for the L.C.C.): The fact that the live rail in the proposed tube differed in position from that of the Metropolitan Railway would not necessarily affect intercommunication, as the collector might be made adjustable.

Witness said, in reply to Mr. Hutchinson (for Behring's Bank) that he could not say whether the removal of the iron sections of the tube where it passed through the clay, and the lining of the tube with brick in cement would result in any further tendency to subsidence.

In reply to the Chairman: The Board of Trade could insist on the automatic block system, but in any case it rested with the driver to obey the signal.

Sir Alexander Binnie, Vice-President of the Institution of Civil Engineers, corroborated the evidence which he gave before the Committees of 1901—2. With regard to the question of the City stations it was undesirable to "dump" the passengers at one point. They should be distributed as much as possible. He would prefer to have three stations, but considered that two were absolutely necessary. As to whether the stations should be under the street, witness recalled the case of the Baker Street and Waterloo Railway. It was at first proposed to have the Trafalgar Square station on private property in Cockspur Street, but the London County Council were of opinion that it would be better to have the station under the street, and the company obtained powers for that purpose. Questioned as to the proposed junction at Hackney: He had considered the safety of that junction, and thought that there was no danger whatever in a junction of that kind. On the Metropolitan at Edgware Road there was a similar junction, which had been worked for years. It would be safe to get even a 1½-minute service on the proposed line.

The Chairman: Do you know of any other tube line in London emerging into the suburbs as an open line?—Yes; the Charing Cross and Hampstead propose to continue in the open to Watford.

Cross-examined by Lord Robert Cecil (for the Colonial Bank): It was undesirable to have sudden crowds in the vicinity of banking premises, but he saw no objection to the situation of the station at Threadneedle Street. He had expressed an opinion that the construction of the line was a matter of urgency; the districts proposed to be served had been waiting for such a line for many years.

In reply to Sir R. Littler: He was aware that the Corporation were of opinion that a line from the City to Walthamstow should pass through Bethnal Green. In his evidence in 1901 he had said that he considered confluent junctions, except in the extreme suburbs, to be unworkable, but that only meant when the trains were to be run at 2½ minutes' service over the whole line.

Cross-examined by Mr. Hutchinson: He agreed with Colonel Yorke that 12 ft. 6 in. was a good size for tubes. He understood that Colonel Yorke's preference for a 13-ft. 6-in. tunnel was entirely on account of the footway which would be possible.

In reply to the Chairman: It was proposed to take away part of the iron sections as the shield went forward and to substitute brick at the bottom and halfway up the sides of the tunnels.

With regard to the question of the station at Threadneedle street, the Chairman thought that perhaps a conference might be arranged between the promoters and the Corporation and the banks which were opposing the Bill and some agreement be arrived at.

Mr. Rigg (for the Corporation) said that he could not agree to that proposal; the company had committed itself by telling the banks that it would not take their land without their consent. The company had attempted to get rid of the opposition of the banks by that means, and had evidently relied on getting the permission of the Corporation to the construction of the station under the street. The Corporation would continue their opposition.

Sir Douglas Fox gave evidence as to the depth down from the surface of the London clay in the City.

On Monday, the 27th ult., it was announced that Sir Douglas Fox had had communication with the Corporation, as was suggested by the Chairman on Friday, but with no result.

Sir Douglas Fox continued his evidence. He said that the depth of the clay was 23 ft. below the surface at the Monument, and 25 ft. at Liverpool Street. The tube would not come within 15 ft. of the top of the clay. Witness produced a plan showing an alternative arrangement whereby there would be an entrance at the junction of Cornhill and Leadenhall Street, the station at the Monument being connected with that entrance by a subway.

Questioned by the Chairman, Witness said that the proposed arrangement at the Monument was, after a train had discharged its passengers, to allow the train to be refilled and to go out on the same line, crossing over to the down line outside the station. This saved a lot of dead-running.

Mr. Hutchinson, for Behring's Bank, cross-examined as to the depth of the line where it passed near the bank. Counsel objected to the station which was proposed to be made near the bank on the ground that injury would follow on account of the junction of two different sizes of tubes. The shafts, he contended, would also tend to affect the stability of his clients' buildings.

Questioned as to the difference in the cost of the line if the tubes were 13 ft. 6 in. instead of 12 ft. 6 in., Witness said that the difference would be £240,000 if the larger tubes were adopted. He thought that there would be no difference in the cost of half-brick, half-iron tubes and tubes wholly of iron. He did not particularly favour the former method of construction.

In reply to Mr. Pember, K.C.: The depth of the station at Bishopsgate Street was 62 ft.; at Liverpool Street the depth of the tube was 63 ft. At Norton Folgate, where the line would pass under the Great Eastern goods depôt, the tubes would be one above the other, the upper being 35 ft. and the lower 54 ft. from the surface of the Great Eastern rails. Sir R. Littler also cross-examined the witness.

Re-examined by Mr. Page, K.C., Witness did not know of any serious accidents on electric tube railways. There had been a lift accident on the City and South London line and there was a fire at Liverpool.

Mr. Edwin Fox (of Messrs. Edwin Fox & Bousfield), a valuer of the Board of Trade, was next called. He had surveyed and valued the land proposed to be taken for the proposed railway.

Mr. Rigg (for the Corporation): Can you tell me in round numbers the sum you have allowed for property proposed to be taken in the City of London?—Yes, between £270,000 and £300,000.

Mr. Steel, late general manager to the Great Northern Railway, the next witness, said that he did not think that enough had been thought of the future in regard to the increase of population. Provision should be made by railways for large increases in the suburbs. He considered the railway to be highly necessary to relieve congestion. Assuming 10 per cent. workmen, he estimated the traffic which the two lines would carry would be 68,000,000 per annum. The line would be fed by tramways at Lordship Lane and Walthamstow. Witness then dealt with the expected receipts of the line. Taking the following fares: Monument to Chequer's Green, 2d.; Monument to Chingford Green, 2d.; and other 3d. and 4d. fares, and assuming that 60 per cent. of the seats in the trains were occupied, he estimated that the gross receipts of the line would be over £521,000. He put the working expenses at £281,000 per annum.

On Tuesday the cross-examination of Mr. Steel was continued by Mr. Pember. Witness thought that the cheap fares would induce a traffic which the Great Eastern Co. did not supply. The company would benefit in respect of the short-distance traffic at the uniform fare proposed.

In reply to Mr. Pollock, K.C.: The line would be constructed and finished as a whole.

The Chairman said he thought the evidence was now tending to show that the larger number of the passengers on the line would be other than of the working class. He was under the impression that the London County Council were merely watching the Bill, and asked Mr. Pollock if he were absolutely opposing. Mr. Pollock replied that the L.C.C. were opposing the Bill as it now stood.

At this point Counsel for the Colonial Bank asked the Chairman if he would ask Mr. Bush (counsel for the promoters) what were the intentions of the promoters with regard to the Cornhill station. He said that his clients had not yet had any definite information on that point. The Chairman replied that he thought that it was through no fault of the promoters, for the Bill was still before the Committee, and that point had not been settled.

Mr. G. C. Cuningham, the general manager of the Central London Railway, compared the proposed line with the Central London as regards the estimated cost. He had made an estimate of the number of car-miles which would have to be run; it came out at about 15,800,000 per annum, which would mean about 8¼d. per mile at the estimated fares, the running expenses being 5d. per mile. The proportion of working-class tickets on the Central London Railway was about 10 per cent. The figures for the six months ended December 31st last were 2,270,854 workmen's tickets out of a total of 22,425,000 passengers carried.

The Chairman asked Witness what proportion of passengers on the Central London were long-distance passengers, and Mr. Cuningham replied that out of a daily total of 140,000, about 20,000 were through passengers. The Committee adjourned.

Leigh Corporation Tramways.

On 22nd, 23rd, 24th, and 27th ult., Mr. Heywood Johnson's Select Committee of the House of Commons considered the Bill of the Leigh Corporation, which sought to empower the Corporation to make new waterworks, tramways, street improvements, &c. The money estimates were £62,500 for the construction of tramways, £9,450 for the electrical equipment of tramways, and £30,000 for the electricity undertaking of the Corporation.

Mr. Weddeburn, K.C., who appeared for the Corporation, said that the rateable value of Leigh was £156,000, and they had a debt of £365,000, but over £203,000 of that debt was represented by loans obtained for the establishment of remunerative undertakings. With regard to the Tramway portion of the Bill, there were several petitions against the proposals, but that of the South Lancashire Tramways Co. was the only one which had any effect on the main principle. He contended that the Corporation had serious ground for complaint as to the conduct of the South Lancashire Tramways Co. In 1898 the St. Helens, Leigh and Bolton Light Railway Syndicate proposed to make a through line of tramways from the boundary of Bolton to the boundary of St. Helens, the line passing through Leigh. Powers for putting that proposal into effect were never applied for, but it was important to mention it, because even in those early days the Leigh local authority protected their own rights. The Council agreed to allow the line to be constructed on condition that they were given free running powers over it, and the right to cross it and to make junctions with it, and Leigh had never seceded from that position. That agreement was put into effect by an Act obtained in 1900 by the South Lancashire Tramway Co., which succeeded the syndicate he had referred to, and was composed of the same people. It had always been clear

that the Council retained the right to construct tramways within its own district, and the Tramways Co. agreed that a clause should be inserted in the Bill prohibiting them from constructing more than the through line with a line connecting the through route with the generating station and car-shed. He trusted that the Committee would see that the undertaking was carried out in its entirety. By the Act of 1900 the tramways company were definitely bound never to oppose the Corporation in the construction of tramways if they did not interfere with the rights of the company as defined by their Act. The company proposed to construct a generating station and car-shed in Leigh, but when the company found the Corporation would not allow them to construct lines across Leigh apart from the through line, they would not build a generating station or car-shed in the town. Therefore the object of having the short connecting line for which they obtained powers had gone, and the line was not constructed. Had it been made, the Council would have had free running powers over it. The Corporation now proposed to duplicate a small part of it in order to make an east-to-west line. The South Lancashire Tramways Co. had a Bill in the House of Lords by which they sought to repeal the section under which the Corporation were given running powers and other privileges, and that, he contended, would be a breach of faith which no Committee would countenance. If the company would construct the short connecting line within two years the Corporation would be satisfied, or the Corporation would construct the line, and in the event of the generating station and car-shed being erected, the Corporation would give the company free running powers.

The Town Clerk of Leigh was then called in support of the Bill, and deposed to the facts as stated by counsel.

On the counsel for the South Lancashire Tramways Co. proceeding to cross-examine, Mr. Wedderburn objected to him going into any matter other than in respect to the line to the generating station.

The Committee upheld the objection, and the proceedings were adjourned to allow of the South Lancashire Tramway Co. considering their position.

On the proceedings being resumed, Mr. E. H. Lloyd (counsel for the South Lancashire Tramways Co.) announced that he would take no further part in the proceedings before the Committee, which would leave the company liberty to carry their case to the House of Lords. The company's opinion was that they would be so restricted by the decision that they would be unable to conduct their case properly, although they had hoped to have been able to show that they were not open to the imputation of bad faith, and also that, in the interests of the district, a through scheme was to be preferred to the local scheme of the Corporation.

Mr. Wedderburn remarked that since the Act of 1900 was passed, there had been a change in the directorate, and the breach of faith with which he charged the company, did not apply personally to the present directors.

The case of the Corporation was then proceeded with, and Mr. Balfour Browne, K.C., on behalf of the South Lancashire and Cheshire Coal Association, asked for facilities for the carriage of goods and minerals over the proposed line within the borough of Leigh. He urged that the line would be virtually part of a complete system of light railways and tramways, covering the whole of South Lancashire between Liverpool and Manchester, with an extension towards the north as far as Preston. The lines were all of the same gauge, and similarly equipped electrically, and the general law affecting light railways should be made applicable throughout. It was the intention of the Association whenever these schemes came before Parliament to ask that they should be put under the general law. The traders of the important towns were awake to the desirability of utilising the tramway system for the carriage of goods as a means of competing with the railway companies, and it was most important that facilities should be given for through booking and so on.

Mr. Wedderburn objected to being brought under an obligation which did not apply to other tramways.

The Chairman announced that however desirable it might be by future legislation to assimilate electric tramways with light railways, the Committee were not prepared in this instance to grant the application.

The Committee afterwards proceeded to deal with the objection of the Lancashire County Council to pay the same contributions for main roads where it was proposed to lay tramways, but this was overruled.

The London and North-Western Railway Co. objected to the proposed line between Leigh Road and West Leigh, as the line would cross their branch railway on the level.

The Committee disallowed the tramway, but suggested that the parties should try and arrive at an arrangement by which the tramway could be carried either over or under the railway.

This concluded the tramway portion of the Bill, and the Committee proceeded to deal with the other matters included in it.

Baker Street and Waterloo Railway (Extension of Time) Bill.—On Thursday last week Mr. Campion, one of the Examiners, had this Bill before him for proof of compliance with Standing Orders. As the Bill was introduced after the date fixed, Standing Orders could not be complied with, and accordingly it will have to go before the Standing Orders Committee, who will decide whether it shall be allowed to proceed. It is sought by the Bill to extend the time limited by the Baker Street and Waterloo Railway Act, 1900, for the compulsory purchase of lands, and for the construction of certain of the railways authorised, for a further period of two years after August 6th, 1905.

Metropolitan District Railway Co.'s Bill.—On Friday the Committee of Referees, presided over by Mr. Parker Smith, considered the application of the Westminster Electric Supply Corporation for a *locus standi* against the Metropolitan District Railway (Various Powers) Bill. Mr. Blennerhassett, who appeared for the Westminster Electric Supply Co., said that Clause 14 of the Bill authorised the Metropolitan District Railway Co. to acquire certain lands on which sub-stations could be erected for the distribution of electricity, &c. By Clause 75 of the Bill the Metropolitan District Railway Co. was authorised to enter into arrangements with the Underground Electric Railway Co., Ltd., the effect of which would be that if these arrangements were carried out the whole of the line would come into the hands of the Underground Co. This Underground Co. was not a statutory company but was a limited company, and they would enter into complete possession of those sub-stations for the distribution of electricity. The Westminster Co. were naturally apprehensive that if the Underground Railway entered into possession of these sub-stations they would enter into competition with them. All he asked for was a *locus* to go before the Select Committee and ask for clauses for their protection. Their apprehensions were excited by the remarks made by Mr. Perks, the chairman of the District Railway, at the hearing of the Charing Cross, Euston and Hampstead Railway, who stated that a great generating station costing £1,000,000 of money was being erected at Chelsea to supply electric power to a number of railways, and naturally to recoup themselves one way would be enter into competition with the Westminster Electric Supply Corporation. They also asked for a *locus* as regarded mains and pipes. Mr. Clode (for the Metropolitan District Railway) said they could not give the Underground Co. any power to supply outside their own purposes. The Referee said he took it that the Westminster Co. were afraid that the Underground Co. would enter into possession of lands under the Bill; that electricity could be sent to the sub-stations from whence they could supply other customers in bulk. Mr. Clode argued that the words in the clause strictly limited the supply to their own purposes. He contended that the company were amply protected by the clause in the Bill with regard to mains and pipes. After consideration in private, the Court disallowed the *locus*.

On the same day the Metropolitan District Railway (Various Powers) Bill was before Mr. Campion, the Examiner, with regard to the application for a new provision, the object of which was to convert the Whitechapel and Bow Guaranteed Stock. Standing Orders were found not to have been complied with, and the provision will accordingly go before the Standing Orders Committee.

Electric Lighting Provisional Orders Bill (No. 1).—On Friday Mr. Campion, Examiner in the House of Commons, found that Standing Orders had been complied with in the case of Electric Lighting Provisional Order No. 1, which confirms a provisional order relating to Mitchelstown in the county of York. The undertakers are the Mitchelstown Rural District Council.

Shropshire, Worcestershire, and East Denbighshire Electric Power Bill.—The Great Western Railway Co. have withdrawn their opposition to this Bill.

Manchester Tramways (Lancashire and Cheshire).—Leave has been given to the Select Committee which will consider the Manchester Southern Tramways (Lancashire) Bill and the Manchester Southern Tramways (Cheshire) Bill to consolidate the Bills into one Bill if they think fit.

Tynemouth and District Tramways.—The Tynemouth Corporation has deposited a petition in opposition to this Bill in the House of Lords.

Electric Lighting (London) Bill.—The Corporation of Wandsworth have presented a petition in the Private Bill Office of the House of Lords in favour of this Bill.

Electric Lighting Provisional Orders (No. 2).—On Monday Mr. Campion, one of the Examiners, had before him Electric Lighting Provisional Orders Bill (No. 2) for proof of compliance with standing orders. The Bill seeks to confirm Provisional Orders granted by the Board of Trade to the following districts:—*Brixham.*—Order granted to the U.D.C. in respect of the Urban District of Brixham, in the County of Devon. *Brumby and Frodingham.*—Provisional Order granted to the U.D.C. in respect of the Urban District of Brumby and Frodingham, in the County of Lincoln. *Dawlish.*—Order granted to the U.D.C. in respect of the Urban District of Dawlish, in the County of Devon. *Horbury.*—The Order is granted to the U.D.C. of Horbury, in the West Riding of Yorkshire. *Hucknell-under-Huthwaite.*—Order granted to the U.D.C. of the Urban District of Hucknell-under-Huthwaite, in the County of Nottingham. *Newton-in-Makerfield.*—Granted to the U.D.C. in respect of the Urban District of Newton-in-Makerfield, in the County of Lancaster. *Orrell.*—Order granted to the U.D.C. of Orrell, in the County of Lancaster. *Scunthorpe.*—Order granted to the U.D.C. in respect of the Urban District of Scunthorpe, in the parts of Lindsey, in the County of Lincoln. *Sidmouth.*—Grant to the U.D.C. in respect of the Urban District of Sidmouth in the County of Devon. *Yeovil.*—Provisional Order granted to the Corporation of Yeovil in respect of the Borough of Yeovil, in the County of Somerset.

Electric Lighting Provisional Order Bill (No. 3).—This Bill, which confirms provisional orders granted by the Board of Trade to the undermentioned districts, came before Mr. Campion for proof of compliance with Standing Orders on Monday, and was ordered to proceed. *Auckland.*—Provisional Order granted to the County of Durham Electrical Power Distribution Co. in respect of the rural district of Auckland, in the county of Durham. *Carisbrooke and Northwood.*—Order granted to the Isle of Wight Electric Light and Power Co. in respect of the parishes of Carisbrooke and Northwood, in the rural district of the Isle of Wight. Power is given to the local authority to purchase after 10 years. *Drayton-in-Hales.*—Order granted to the Market Drayton Electric Light and Power Co., Ltd., in respect of a portion of the parish of Drayton-in-Hales in the

rural district of Drayton, in the county of Salop. *Illogan.*—Order granted to the Urban Electric Supply Co., Ltd., in respect of the parish of Illogan, in the rural district of Redruth, in the county of Cornwall. Power is given to the local authority to purchase after seven years if they think fit. *Ingleton.*—Provisional order granted to the Ingleton Electric Lighting and Power Co., Ltd., in respect of the parishes of Ingleton and Thornton-in-Lonsdale, in the rural district of Settle, in the West Riding of the county of York. *Port Dinorwic.*—In this case the undertaker is Mr. Geo. Wm. Duff Assheton Smith, of Vaynol Park, Carnarvon, and his successors, and the area is portion of the rural districts of Gwyrfai and Ogwen, in the county of Carnarvon *Sevenoaks.*—Order granted to the Kent Electric Power Syndicate Ltd., in respect of the urban district of Sevenoaks, in the county of Kent. *South Shields.*—Provisional order granted to the County of Durham Electrical Power Distribution Co., Ltd., in respect of the rural district of South Shields, in the county of Durham. *Stafford.*—Order granted to the Corporation of Stafford in respect of parts of the parishes of Seighford, Tillington, Hopton and Coton, and Beswick and Castle Church, all within the rural district of Stafford. *Wilmslow.*—Provisional order granted to the Alderley and Wilmslow Electric Supply Co. in respect of the urban district of Wilmslow, in the county of Chester.

Coventry Electric Tramways.—This Bill, which authorises the Coventry Electric Tramways Co. to construct additional tramways, &c., came before the Unopposed Committee of the House of Commons, presided over by Mr. Jeffreys, on Monday. The estimated expense of constructing the tramways is £28,397. The existing tramways are partly within and partly without the City of Coventry, and power is given for the Corporation to purchase the undertaking intact. Power is also given to raise £18,000 additional capital. The preamble of the Bill was found proved, and the measure was reported for third reading.

West Cumberland Electric Tramways.—The Egremont, Arlecdon and Frizington and Harrington Urban District Councils have withdrawn their opposition to this Bill.

THE ELECTROLYTIC REDUCTION OF CHLORATE OF POTASSIUM.

By Dr. D. TOMMASI.

With regard to the papers recently published by Bancroft,* Barrows,† and Brochet‡ on the electrolytic reduction of chlorate of potassium, I think it may be worth mentioning that in 1877,§ when occupied with the same question, I arrived at results almost identical with those obtained by the above-named scientists.

This is, in fact, what I observed :—

If we electrolyse a solution of chlorate of potassium acidulated with sulphuric acid, we obtain, according to the nature of the anode, an oxidation or a reduction of the chlorate.

With platinum electrodes there is a formation of perchlorate at the anode without any trace of chloride at the cathode.

If we use a platinum cathode and a zinc anode,‖ chloride of potassium is produced at the anode only, but we do not observe any reduction of the chlorate at the cathode. The reduction of this compound, in this case, cannot be attributed to the hydrogen, but to the zinc, which on combining with the oxygen of the chlorate to form oxide of zinc would reduce the chlorate to chloride.

1. $Cl\,O^3\,K + 3\,Zn = Cl\,K + 3\,Zn\,O.$
2. $3\,Zn\,O + 3\,SO^4\,H^2 = 3\,SO^4\,Zn + 3\,H^2\,O.$

It is the same when chlorate of potash is reduced by zinc and diluted sulphuric acid. In this case, as I have shown,¶ the transformation of the chlorate into chloride is not due, as is generally supposed, to so-called nascent hydrogen, but to the combination of the zinc with the oxygen of the chlorate.

If we electrolyse a solution of chlorate not containing any sulphuric acid, we observe at the anode a white precipitate of hydrate of zinc.

The perchlorate of potassium treated under the same conditions as the chlorate, undergoes no reduction, even when a zinc anode is used.

I also observed the reduction of chlorate of potassium under the following conditions :—

If, in a solution of sulphate of copper containing this chlorate, we introduce granulated zinc, we notice that after a few minutes the mixture becomes heated to such a degree that it soon enters into ebullition, and the whole of the chlorate is transformed into chloride, whilst part of the copper passes into the condition of cuprous oxide.

Chlorate of potassium is also reduced by the action of zinc on mercuric nitrate or acetate of lead, by the action of tin or iron on sulphate of copper, &c. ; but it is not reduced by the amalgam of sodium, which is used as a neutral solution, alkaline or acid. In the presence of diluted acetic acid zinc does not reduce the chlorate, but the zinc-copper couple reduces it partially.*

* *Transactions* of the American Electro-chemical Society, Vol. i. p. 65.

† The *Journal of Physical Chemistry*, Vol. vi., p. 417.

‡ *Comptes Rendus* of the Académie des Sciences, January, 1903.

§ "Traité d'Electro-chimie," by Dr. D. Tommasi, p. 476.

‖ In this experiment we may employ copper or lead in the place of zinc.

¶ See the *Bulletin* de la Société Chimique de Paris for 1882, Vol. i., p. 148; the "Traité d'Electro-chimie," by Dr. D. Tommasi, p. 105; and the "Traité des Piles Electriques," by Dr. D. Tommasi, p. 121.

* This couple is obtained by immersing a plate of zinc in a 1 per cent. solution of sulphate of copper.

BUSINESS NOTES.

Electrical Wares Exported.

Week ending April 29th, 1902.		Week ending April 28th, 1903.	
Amsterdam	Value £65	Auckland	Value £59
Auckland	220	Azores. Teleg. mat. ..	3,081
,, Elec. cable ..	4,608	Bombay	263
,, Elec. cars ..	11,061	,, Teleg. mat. ..	150
Bombay	87	Bremen. Teleg. instruments ..	2,500
,, Teleg. wire ..	103	Brisbane	80
Brisbane	147	Buenos Ayres	30
Buenos Ayres	83	Calcutta	604
,, ,, Teleg. mat. ..	250	Cape Town	80
Calcutta	664	Demerara	42
Cape Town	126	Durban	1,519
,, Teleg. mat. ..	693	East London	994
Colombo	23	Fremantle	100
Copenhagen. Teleg. cable ..	93	Hamburg	3
Durban	394	Hobart	794
East London	85	Honolulu	886
Gothenburg	298	,, Teleg. mat. ..	806,878
,, Teleg. wire.. ..	23	Kure	572
Hamburg	10	La Plata. Teleg. mat. ..	75
Hong Kong..	1,932	Larache	350
Launceston	95	Launceston	81
Malta	105	Lisbon. Teleph. mat. ..	615
Odessa	90	Manila. Teleg. mat. ..	981
Osaka	130	Melbourne	243
Perth	4,030	Montreal	13
Port Elizabeth	518	Napier	181
Rangoon	35	Otago	3,600
Shanghai	159	Penang	154
Sydney	492	Perth	61
Trinidad. Teleg. mat. ..	102	Port Elizabeth	357
Vera Cruz	6,101	Port Said	35
		St. Petersburg. Teleg. wire ..	469
		St. Michaels	39
		Shanghai	926
		Singapore Teleg. mat. ..	224
		Sydney	463
		Wellington	667
		,, Teleg. mat. ..	337
		Yokohama	177
Total ..	£32,792	Total ..	£918,576

Foreign Goods Transhipped.

Bremen. Elec.lghtg.apprts.	Value £70	Sydney. Elec. goods ..	Value £115
Calcutta. Elec. lghtg. apprts...	64		
Fremantle. Elec. lghtg. plant	4,396		
Total ..	£4,530		

Installation Contracts.—Messrs. Drake & Gorham, of Manchester, have secured a contract from the Steel Company of Scotland, Hallside Works, Newton, near Glasgow, for an electric lighting installation for 130 arc lamps and incandescent lighting, with main switchboard; also an order from Lord Boyne for a complete electric lighting installation consisting of over 1,000 lights, with steam plant, for Brancepeth Castle, near Durham. The generating plant consists of two boilers and two combined sets, &c., the whole being arranged in duplicate.

Australian Patents.—Messrs. W. P. Thompson & Co., patent agents, of Liverpool, learn from their Melbourne agent that in Victoria a Bill has just passed both Houses of Parliament, and will become law in another week or two, by which provisional specifications will be exempted from examination as to novelty. In Western Australia assignments of patents will henceforth be subject to a duty of 6d. for every £5 consideration money instead of 10s. per deed as hitherto, but if no consideration be mentioned the stamp duty will be 10s. This is in addition to the cost of registration of the deed, and applies apparently not merely to patents but to trade marks also. The Government have in prospect an Act for extending a single patent to the whole of Australia, but this is almost certain not to come into force till January 1st, 1905.

Bankruptcy Proceedings.—The first meetings and public examination in *re* R. H. Thomas, medical electrician, of Canning Street, Liverpool, will take place at Liverpool, on May 6th and 7th respectively.

Dissolutions and Liquidations.—A first meeting of the creditors of the Warrington and District Electric Light and Power Co., Ltd., was held on April 22nd, at the office of the Official Receiver in Manchester. Mr. Dibb, the Official Receiver, presided. He said the liabilities to creditors of this company were estimated at £5,114 3s. 10d., and the assets at £1,695 10s. 4d., showing a deficiency, as between the creditors and the company, of £3,418 13s. 6d. There was also a liability to contributories of £2,552, making the total deficiency £5,970 13s. 6d. It was agreed to appoint Mr. Edwin Bradshaw, of Warrington, and Mr. E. E. Johnson, of Manchester, joint liquidators, with a committee of inspection.

Messrs. J. E. Sharples and H. Taffs (Sharples, Taffs & Co., electrical engineers, Manchester) have dissolved partnership. Mr. Sharples will attend to debts and continue the business under the style of Sharples & Co.

The petition *re* the Mica Manufacturing Co., Ltd. (petition of the Development and Finance Co., Ltd.) was before Mr. Justice Byrne in the Companies Winding-up Court on Tuesday. Mr. G. F. Hart, in support of the petition, asked for week's adjournment to enable his clients to consider the evidence filed on behalf of the company. Counsel for the company said there was no ground for a winding-up order. His Lordship directed the petition to stand over for a week as asked.

The matter of the British Electric Street Tramways, Ltd. (petition of A. J. Panic) was before Mr. Justice Byrne in the Companies Winding-up Court on Tuesday, and was directed to stand over for a fortnight to enable the petitioner to answer affidavits filed on behalf of the company.

The firm of Lacey, Clirehugh & Sillar will in future be carried on in the name of Lacey & Sillar, Mr. Clirehugh having retired from consulting practice.

In connection with the above we are asked to announce that Mr. S. V. Clirehugh has opened an office at the Mansion House Buildings, 4, Queen Victoria Street, E.C., and at College Land, Manchester. Communications should be addressed to Queen Victoria Street.

German Electrical Industry.—Consul-General Schwabach, reporting on the trade of Germany for the year 1902, comments on the general depression in trade and industry which was experienced during the previous year, 1901, and states that it continued to make itself felt, though in a less degree, during 1902. The most unfavourable position of all, he remarks, was that of the electrical industry, only those works keeping going which were sufficiently cautious during the boom of 1900 not to enlarge their premises and increase their expenses without due forethought. Quoting from the reports of the various trading companies, Mr. Schwabach shows that in electrical works dividends fell during the year from 5·92 to 4·13 per cent., while in machine building dividends fell from 6·13 to 4·77 per cent. The installation of electric light for small towns where no natural motive power exists, he states, has been proved unprofitable, and gas is therefore retained in such localities. In conclusion, Mr. Schwabach remarks:—"The electrical industry has not yet recovered from the blow it received in 1900 and 1901. Employment during the past year was as difficult to obtain as in the year before; little was done in the construction of electric central distributing stations and of street railways. The same want of proportion exists between production and demand, which worked so calamitously in previous years, and the fact that certain factories still continue to increase their production does not add to the likelihood of a rise in prices. In the summer of last year a combination of electrical firms was discussed for the purpose of watching the interests of the trade, and at the end of the year and the beginning of this, combinations of the largest German firms actually took place—first between the Aktien Electricitäts Gesellschaft and the Union, then between Siemens and the Nuremberg Schuckert Works, which latter firm had suffered very severely from the disastrous crisis of the previous years. A complete amalgamation is not contemplated, but certain branches are combined in order to cheapen the cost of production. The export prices of electrical manufactures were not remunerative." Referring to the motor-carriage industry, he states that benzine motors are now mostly used, electric motors being rare.

Portugal and Electrical Imports.—Mr. H. Harrison, commercial attaché to His Majesty's Legation (Lisbon) reports that there was a considerable decrease in the importation of electrical machinery into Portugal during 1902. The fewer classes of machinery, he states, cannot be manufactured in the country, as the demand is not sufficient to make it profitable. But the high duties, which raise the price of machinery, discourage its use, consequently in the year 1902 there was a general decrease in the imports of machinery.

Freehold Works for Sale.—Messrs. P. Huddleston and Co. will sell by auction on May 22nd the freehold manufacturing premises of the Consolidated Telephone Construction and Manufacturing Co. at Bond Street, Coventry, the company having removed to their new works in London. Some further information appears in our advertisement pages to-day.

Uralite.—The contract for the new Naval College buildings at Osborne, Isle of Wight, has now been placed. Nearly a quarter of a million feet of Uralite, the new fireproof building material, will be used.

Catalogues and Lists.—The Nernst Electric Light Ltd., of 82, Victoria Street, S.W., has issued a 50 pp. catalogue, in which the advantages of the Nernst lamp are stated, and the lamp itself is described in detail, with excellent illustrations of the parts. Life and efficiency tests are followed by a comparison of the cost between Nernst and ordinary glow lamps. Different types and models of the lamps are shown, and prices are given of lamps and accessories therefor. The pictures include a view of the Coronation Arch, which formed so effective an illuminative attraction at Whitehall last summer; also one of "Big Ben" at Westminster; a view showing the style of Nernst street lamp used at Barnes; and one of the interior of Edinburgh Museum.

Pamphlet No. 202 of the British Schuckert Electric Co., Ltd., gives a full account of the Schuckert surface contact tramway system.

Mr. William Boby, of Salisbury House, E.C., has placed before us a copy of his well illustrated catalogue (No. 14) of the Chevalet-Boby patent heater detartariser. The principle of the apparatus is clearly explained with the help of useful diagrams and photographs of the apparatus which Mr. Boby has installed at the Metropolitan Electric Supply Co.'s station and other electricity works.

A new catalogue illustrating Erith's patent underfeed stoker has been brought out by Erith's Engineering Co., of 70, Gracechurch Street, E.C.

A leaflet describing the "Criton" patent water softener has been received from the Pulsometer Engineering Co., Ltd., of Reading.

A new list (April) of continuous-current motors has been issued by the Lister Electric Manufacturing Co.

We have before us a copy of a new list of the Keighley patent house service fuse boxes, also street service boxes and accessories. The devices are very fully illustrated by means of diagrammatic and good half tone blocks. The makers are the Keighley Electrical Engineering Co., Ltd., of Vulcan Works, Keighley.

The Lahmeyer Electrical Co., Ltd., has issued two new pamphlets. One describes the Lahmeyer motors and apparatus for driving metal working machines; the other gives particulars of their continuous-current dynamos for electro-chemical purposes.

We have received a list of 1,300 motors which have been supplied by Messrs J. H. Holmes & Co., of Newcastle, for driving printing machines. The *Globe* (London) has been employing electrical machinery on the Holmes-Clatworthy system for all of its printing work for a couple of months.

Belgium.—La Société Belge pour l'Eclairage Public par l'Electricité (système Tudor), of Brussels, reports a profit of £2,004 for the last financial year.

Trade Announcements.—On April 1st the Electric and General Stores Co., of Sunderland, opened a branch at 6, Whitehorse Street, Boar Lane, Leeds, under the management of Mr. W. R. Straughan, as wholesale suppliers, the company keeping large stocks of all accessories at both establishments.

The A.B.P. Accumulator Co., Ltd., have appointed Mr. E. H. Orchard as their London representative, at 39, Victoria Street Westminster, S.W.

Nernst Lamps.—We have received from the Electrical Co., Ltd., of 122, Charing Cross Road, W.C., copies of testimonials from users of Nernst lamps in Gravesend, Doncaster, Liverpool, Burnley, Worthing, London, &c., bearing testimony to the economy derived from their use. In Gravesend, where an installation of 48 ½-ampere Nernst lamps replaced incandescent gas burners, the renewals at the end of three months averaged 960 hours, individual burners going over 1,650 hours. The demand for these lamps will, no doubt, increase rapidly, when their good qualities have been fully substantiated and the public become convinced as to their cheap running.

Book Received.—"La Compressibilité des Gaz réels," by L. Décombe. Paris: C. Naud. 2 fr.

ELECTRIC LIGHT AND POWER NOTES.

Axbridge.—The Board of Guardians has decided to have the electric light installed in the workhouse, and a loan of £850 has been applied for to cover the cost.

Barnstaple.—The T.C. proposes to extend the electric lighting cables outside the compulsory area, a canvass having resulted in over 100 consumers being secured.

Bradford.—The E.L. Committee has under consideration an offer from a manufacturing firm in the Legrams Lane district of the city to take some 1,200 H.P. for motive power purposes. It is probable that this will, if carried out, necessitate the adoption of H.T. machinery and mains.

Bury St. Edmunds.—The estimated income for the past year was £1,485. The amount actually received was over £2,000. The consumers had increased from 94 to 141; lamps from 4,386 to 5,261; motors from 43 H.P. to 81 H.P.; units sold from 39,935 to 67,746 (not including public lamps); public lamps, 8 arcs and 119 of 16-C.P. to 14 arcs and 400 of 16-C.P. The cost of street lighting last year amounted to £773 9s. 2d.

Cambridge.—The T.C. has requested the Electric Supply Co. to insert in its proposed extension order a clause giving the Corporation the option of purchasing the undertaking otherwise than by the promotion of an Act of Parliament.

Carnarvon.—The T.C. in committee has provisionally signed a draft agreement for the introduction of an electric lighting scheme for the town. The Council is to provide the capital, and the scheme will be worked by a company, who are to pay interest on the sinking fund, and the Council will have the option of taking over the works in a certain number of years. The agreement will be submitted for confirmation to the next Council meeting.

Chatham.—The Board of Guardians has decided to have the electric light installed in the Cottage Homes. Energy will be supplied at 4d. per unit.

Chicago.—Consul Wyndham, reporting on the trade of the consular district of Chicago for the year 1902, states that manufacturers of electric supplies have increased their sales enormously, and are behind with their orders. About 1,000 elevators in Chicago are now run by electricity, and motors for all kinds of work are being more and more employed. One electric supply house has had a small cottage of one room, 12 ft. by 16 ft., built, which is moved from place to place in the city, to demonstrate the use of electricity in housekeeping.

Cromer.—The U.D.C. intends to experiment with arc and incandescent electric lamps and high-pressure gas lamps for street lighting.

Dundee.—The electrical engineer has reported that the electric supply network in the centre of the city is so weak in many places that it is only a question of a few months before a succession of severe breakdowns would take place. The engineer suggested that in the central area, the whole of the distributors be drawn out of the iron pipes in which they are laid, and that there should be laid down entirely new three-way distributor ducts to receive new cables with properly-designed distribution boxes. The estimates involve the relaying of 8,300 yds. of three-way ducts and distributors complete with connection boxes, and all the labour involved by the changing over of consumers from the old to the new mains at a cost of £9,843 12s. The probability of being able to effect this change-over without interruption to the supply would, in great measure, depend upon whether the Council decided to pay the cost of a change-over to the remainder of the consumers who were still on the old 100-volt system.

Dungannon.—With reference to the refusal of the L.G.B. to sanction a loan for E.L. purposes, a scheme has been submitted by the National Electric Wiring Co., Ltd. It was decided to adjourn the matter until the Council ascertains whether it can legally transfer the prov. order.

Edinburgh.—The estimated expenditure for the coming year is reckoned at £46,116, as against an estimated expenditure for the current year of £44,455, and an actual expenditure for last year of £39,156 13s. 5d. The estimated revenue for next year is £111,460, compared with an estimated revenue for the current year of £100,795, and an actual revenue last year of £90,960 9s. 5d. The capital expenditure is estimated at £52,820.

Faversham.—Replying to an application for an extension of time for the completion of the electric lighting works, the B. of T. has informed the T.C. that it has no power to grant the request, but, under the circumstances, will postpone for one year, from July, 1903, the consideration of the revocation of the order.

Felixstowe.—The U.D.C. has decided to light the Promenade with arc lamps. It is proposed to erect 36 lamps at a capital cost of £1,500 and an annual cost of £465.

France.—Messrs. Schneider & Co., of Le Creusot, France, have just completed two 200-H.P. gas engines on the Delamare-Debouttéville system for the Champagne works. They are adapted to utilise the waste gases of the blast furnaces, and are intended for electric lighting purposes.

Germany.—The establishment of a large central electricity generating station in the town of Zittau has just been decided upon. It will supply energy for electric lighting purposes and for an electric tramway that is to be constructed.

Gravesend.—The T.C. has applied to the L.G.B. for a loan of £12,544 for electric lighting purposes.

Hackney.—Since the opening of the destructor works, £830 per annum has been paid to a contractor to keep the ground clear of surplus bye-products. At a meeting of the Electric Light Committee of the Borough Council this week an offer by Mr. G. Cotching, of Walthamstow, to take the whole of the clinker, fine ash and fine dust free of charge for 12 months, was considered. It was resolved to accept the offer, on Mr. Cotching finding sureties for the carrying out of the agreement.

Holyhead.—At a recent meeting of the U.D.C. a motion to postpone the electric lighting scheme was, after an animated discussion, defeated.

Hull.—At a meeting of the E.L. Committee, a motion was adopted requesting the city engineer, in conjunction with the electrical engineer, to furnish (1) information as to the estimated value of the whole of the useful plant, including land, buildings, machinery, &c., to see if the present outstanding indebtedness is represented by the useful plant; (2) a statement analysing the capital expenditure up to date to compare with the foregoing; (3) a statement for the last five years showing the cost per unit sold:—Generation charges, distribution charges, standing charges, sinking fund, and interest charges, and revenue per unit sold, separating lighting and power receipts; (4) a statement showing increase in sales and receipts compared with increase in capital outlay; and (5) the result of last year's working.

Hythe.—The T.C. has entered into a contract with the Folkestone Electric Lighting Co. to supply electricity to the town for public lighting at a cost not exceeding the present price of gas.

Italy.—A company has just been formed in Rome to be known as La Societa Catanesi di Elettricita, to establish a central electric power station at Catania. The water-power of the Alsantara will be utilised.

Jedburgh.—In regard to the electric lighting of the town, the plans have been passed on behalf of Messrs. Crompton and Co., and the work will be proceeded with immediately.

Kirkby-in-Ashfield.—The U.D.C. has decided to apply for a prov. order for supplying electricity. Mr. Hammond has been appointed consulting engineer in connection with the scheme.

Londonderry.—The T.C. has held a special meeting to consider the motion that the private lighting and power scheme, decided on by the Council, for which a loan of £35,000 has been sanctioned, should be abandoned. After prolonged discussion, the motion was defeated by 22 votes to 12.

Loughborough.—The T.C. has instructed Mr. C. H. Gadsby, consulting engineer, to advise as to what modification in the capital cost of an electricity scheme for the borough could be effected by utilising a water gas plant at the gas works for obtaining producer gas for power purposes.

Middleton.—There was no opposition at the L.G.B. inquiry into the application of the T.C. for a loan of £6,000 for electricity purposes. Part of the loan is in respect of the extension of the plant consequent on the construction of the tramways to Middleton Junction.

Newquay.—The U.D.C. has engaged Messrs. Enright and Co., at a fee of 15 guineas, to advise them on the question of lighting the town by electricity.

Ramsgate.—The T.C. has appointed Messrs. Handcock and Dykes consulting engineers to the borough.

Sandringham.—Before the return of the King to his Norfolk home, a complete transformation will have been effected in the matter of lighting, gas being entirely superseded by electricity. The system will include York Cottage, the stables, dairy, kennels, and possibly the Park House, Church, Rectory, schools, &c., on the estate. The work is in the hands of the Singer Co.

Spain.—Negotiations are in hand at Bilbao for the formation of an electricity supply company on the co-operative system. It will be known as the Sociedad Co-operativa de Electricidad de Bilbao, and the proposed capital is £24,000. According to the project, three sets of 220-KW. gas engines and dynamos will at first be installed, the power house to have room for doubling the plant when necessary. It is estimated that the new company will be able to supply electricity at a cheaper rate than at present.

Stirling.—The representatives of Stirling, Falkirk, Alloa, Bathgate and Grangemouth met in the above town to discuss the provisions of the Scottish Central Electrical Power Order. It was ultimately decided to recommend the respective Town Councils to take joint action in opposing the order.

The Lighting Committee has been negotiating for years with a view to the conversion of the tramways from horse to electric haulage, but so far they have not been successful. The Lighting Committee is now authorised to ascertain the cost of securing a good tramway service under the management of the Corporation.

Tiverton.—Mr. J. Enright has submitted to the T.C. a report on the proposed electric light installation for the town. He advices the Council for the present to confine the area of supply to Station Road, Gold, Fore, Bampton, Newport and St. Peter Streets, Angel Hill and Bridge Street, the most thickly populated portion of the town. The suggestion to utilise the water power of the River Exe, he says, is impracticable, because of the cost of water rights and the variable volume. He estimates the capital outlay at £13,255, and with a supply of energy at 6d. per unit, an annual revenue of £2,350, and a surplus of £621, or 4¾ per cent.

Tynemouth.—The deficiency on the electricity undertaking for the past year was about £600, but this was after putting £700 to the depreciation account.

Whickham.—The B. of T. has granted a prov. order for electric lighting to the U.D.C.

ELECTRIC TRACTION NOTES.

Aberdeen.—The Tramways Committee of the T.C. has recommended that a two-shift system of running the electric cars should be adopted after June 1st, the men thus having a 48-hours week, exclusive of Sunday labour. An adjustment of the wages is also recommended.

Batley.—The B. of T. has declined to give a ruling respecting the dispute between the T.C. and the B.E.T. Co. as to the exclusive right of the former to supply current for the tramways to be constructed within the borough. The B.E.T. Co. wishes to take current either from Dewsbury or Heckmondwike.

Belfast.—The deadlock in the tramway question is now likely to be got over, as a scheme has been prepared by which, if successfully carried out, the Corporation will acquire the undertaking in August next. The preliminaries for the electrification of the Whitewell and Cavehill line are about to be commenced.

Birmingham.—The Tramway Committee will report to the next meeting of the Council in favour of the municipalisation of the tramways. The Committee states that the offers received are not sufficient to justify it in handing over the working of the tramways within the city to a company. It therefore recommends that the proposals of the B.E.T. Co. be not accepted, and that the Committee be authorised to proceed to carry out the recommendation approved by the City Council in 1899 in favour of the Corporation working the lines and taking tolls on the expiration of the existing leases.

Blackpool.—The Council has been able to hand over £2,249 from the trams in relief of the rates, as compared with £3,479 last year.

Bradford.—The B. of T. has been recommended by Major Pringle to sanction the average speed of the electric tramcars in the borough being increased from 8 to 12 miles an hour where there are no inclines, and where there is a measure of risk from 4 and 6 miles to 6 and 9. This will effect a saving of several thousand pounds per annum.

Cork.—The electric tramcars are said to cause a dust nuisance on one section. In dry weather the passage of the cars is sufficient to keep the light limestone dust in motion, and it is complained that this is injurious to health and property. The Council supplies water for the company to water its tracks. The R.D.C. has been discussing the matter, which has been referred to the county surveyor to look into.

Electric Railway Traction.—Last Friday's *Engineer* says:—"While electric inter-urban railways or light railways are multiplying very rapidly in the United States, only a very few of such lines are built with the third-rail conductor, the overhead trolley wire being used in most cases, even for lines intended for high speed service. The Chicago and Aurora line is the most important of the third-rail lines, being 56 miles in length, operated by trains of cars on the multiple-unit system at speeds of 50 to 60 miles an hour. Another line is the Grand Rapids and Muskegon Railway, 35 miles in length. The road is 17 miles shorter than competing steam railways between the same points, and is built entirely upon its own land, except for short distances where it runs through the streets of towns. These aggregate only 2,500 ft., and are fitted with the overhead trolley. The permanent way is of 70-lb. flange rails, and the third rail is a 65-lb flange rail. All railways are crossed by steel bridges, and at road level crossings the third-rail is broken, the ends being connected by a cable buried in the ballast. The power house has four Babcock & Wilcox water-tube boilers of 250 H.P. each, with mechanical stokers. The waste gases pass to a circulating economiser, to vertical tandem exhaust fans, and thence to a steel chimney extending only 15 ft. above the roof. The engine room has six generating units, each consisting of a Westinghouse vertical compound-condensing engine and a 250-KW. generator. Three of the generators are 390-volt, three-phase alternators; the others are double-current machines, furnishing both 650-volt direct current and 390-volt alternating current. The transmission line carries a current at 16,600 volts, which is reduced at two sub-stations. The cars are all of the double-bogie pattern, the passenger cars 52 ft. long, seating 56 persons, and the parcels wagons 40 ft. long. Each car has two 150-H.P. motors on one bogie."

In a recent editorial note in the American *Railway and Engineering Review*, some American electric railway work is referred to as follows:—"Railway men who have given any study to the subject of electrically equipping existing branch lines of steam roads well understand that more or less wild speculation is continually being written concerning future prospects in this direction. Many men who have a good general knowledge of electricity and its applications allow their prophetic instincts to carry anticipations beyond the practical limitations in this field of electrical work, for the question of the adaptability of electric transmission and the installation of electric motors to handle the traffic of a given situation is subordinate to the character of the service required and other features of the traffic conditions. Just a word with reference to the experience with some of the steam lines which have been electrified within a few years back will serve to illustrate the control which these principles have over the matter. About the first steam road to be electrically equipped was the Nantasket Beach branch of the New York, New Haven and Hartford Railroad, which was converted over to the trolley system in 1895. The fares were reduced, and as a result of a more frequent service there was at first a large increase in business, but more recently the traffic has fallen off, and it is now stated officially that this branch of the road is unprofitable. The line of this same road between Hartford and New Britain, equipped with a third rail at a later date, has yielded better results, and electric operation in this case is generally supposed to be satisfactory to the railroad company. About two years ago this same road equipped a 20-mile branch, from Providence to Fall River, with overhead trolley, reducing the fare from 50 to 20 cents, and increasing very much the frequency of the service. There has been a large increase of traffic, and the financial outcome of the undertaking seems promising of success. An experiment of the Pennsylvania Railroad in equipping a branch of its road between East Burlington and Mount Holley, N.J., a distance of seven miles, with the trolley, has not resulted successfully, as there has not been traffic enough to pay. Thus far, therefore, the electrical operation of steam roads converted over for the purpose has not been an unqualified success."

France.—The work of converting the tramways at Dunkirk to electric traction is proceeding apace. It is expected that one line will be ready for traffic in June next.

Glasgow.—At the meeting of the Cathcart District Railway Co., held in Glasgow on Monday, the decrease in the company's revenue, consequent on the competition from electric tramways was referred to. The speaker said that the Corporation were taking away revenue created by the company after the very uphill work of the latter in opening up the district served.

Greece.—Consul Wood, in his report on the trade and commerce of the Morea and the Provinces of Acarnania and Ætolia for the year 1902, states that during the year under review electric trams have been established in Patras, running along some of the principal streets. He remarks that they have proved a great boon to the townspeople, especially during the summer months when the heat is great.

Liverpool.—The Tramways Committee has decided to recommend the Council to apply to the B. of T. for sanction to borrow £18,000 for the reconstruction of tramways and a car shed in the district of Litherland.

London.—ISLINGTON.—The B.C. on Friday sanctioned the length of tramway in Archway Road within the boundary being constructed with a view to overhead electrical traction. The line is authorised by the London County Tramways Act, 1900.

Manchester.—On Saturday last, shortly before noon, a guard wire protecting the overhead equipment at the corner of Stretford Road and Oxford Street gave way and fell upon the trolley wire, causing a fusion of part of the wire, and cutting off the current in that particular area. Information was at once sent to headquarters, and workmen were despatched, who were not long in repairing the mischief. There was a serious dislocation of the traffic; the two streets affected being blocked with cars for more than a mile. Cars travelling from town to Brooks's Bar were diverted along another route.

New York City.—On April 1st the Interborough Rapid Transit Co. took over the management of the Manhattan Elevated Railway. The same company will operate the subways now in course of construction in New York City, and will thus control the most important transportation systems in Greater New York. It is to be expected, says our New York namesake, that the co-ordination of the two systems—the elevated and the subway—will bring about decided improvements in the transit facilities of the city. The two systems will certainly work together better for the same end than if their interests conflicted.

Southampton.—The Corporation Electricity Committee has fixed the price of current to the tramways at 2½d. per unit.

Southport.—There is a loss of about £1,200 on the tramways system this year. The receipts have been £16,400, and payments £17,600. Working expenses have swallowed up £11,200. There is an apparent profit of £5,200, but £6,400 has to be paid away in interest and sinking fund.

Spen Valley.—The B.E.T. Co.'s Spen Valley tramway system was inspected on Friday last by Major Druitt, of the Board of Trade. The length of the track, which is about three miles, extends from the Batley boundary to Cleckheaton, passing through Heckmondwike and Liversedge. Major Druitt gave the company temporary permission to run the cars until official sanction is given by the Board of Trade. With the exception of a short stretch of road between Dewsbury and Heckmondwike, which is in the Batley borough, there is now a through line from Cleckheaton to Thornhill, about six miles in length. The Board of Trade has been approached with respect to this piece of road, and it is stated that arrangements have been come to whereby the B.E.T. Co. will at an early date be able to connect the Dewsbury and Spen Valley sections. Both the Batley Corporation and the company are to construct a track on the road in question, and each grant the other running powers.

Progress is being made by the Batley Corporation with their tramways. Cables and feeders are now being laid, and a start has been made with the overhead equipment.

Wolverhampton.—Another meeting of the Corporation Tramways Committee was held on Friday last week for the purpose of further considering Mr. C. E. C. Shawfield's report, and deciding as to what course to adopt with respect to the Lorain surface contact system. The meeting, as usual, was held with closed doors, and in the absence of any official communication being made to the press, the greatest difficulty was experienced in obtaining information. The meeting lasted over two hours, and from what has leaked out, it is evident that the members are acutely divided. A letter was submitted from Mr. Wetmore, the representative of the Lorain Co., in which he stated that he did not agree with some of the conclusions of the electrical engineer and of the borough surveyor (Mr. Green), respecting the conditions of the contact boxes and the track. He claimed that at least 4,000 of the boxes were not defective, and he made several overtures to the Committee with a view to meeting the wishes of the members. On Mr. Shawfield and Mr. Green being appealed to, however, both strictly adhered to the statements contained in their respective reports. The sup-

porters of the Lorain system state that the Committee then resolved, by six votes to four, to recommend the Council to take over the 11 miles of Lorain track already constructed on condition that the Lorain Co. make certain alterations and improvements, which, it is believed, they are willing to do. These include, amongst other things, new and more durable tops to the contact boxes. If, however, the Lorain Co. should not agree to these changes, which are to be carried out to the satisfaction of Mr. Shawfield, then the Committee recommend that the whole question be referred to arbitration. According, however, to one of the members of the Committee who is opposed to taking over the track, the Committee were divided as follows:—Five were in favour of the recommendation, three against, and two (including the Mayor) preferred to remain neutral. One of the Committee has hitherto been a strong advocate for the Lorain system. The Mayor pointed out that at such a critical stage in these negotiations it was essential that expert advice should be obtained, and he reminded the Committee that when at the starting of the Lorain system expert opinion was suggested, Alderman Mander (chairman of the Committee) then remarked that the proper time to get such counsel was not at the commencement of the system, but after the trams had been running for some time. This, therefore, in the view of his Worship was an opportune moment to secure additional advice before making any recommendation to the Council. Subsequently a resolution was submitted that the opinion of an expert should be obtained, and that the report of the electrical engineer should be placed in his hands. This was seconded and put to the meeting, but on a division it was lost by one vote. It has been already pointed out that though the Tramways Committee claim a profit of over £3,000 on the nine months' working, no allowance whatever has been made for a reserve fund, nor for depreciation. Nor has anything been set aside for the interest on the capital which was expended on the purchase of the old tram route, nor for legal charges. This interest amounts, it is understood, to about £1,600. Again, against the profits, there must be placed the loss on the horse traction section of the lines, which is over £5,000. These two items together make nearly £5,000, which entirely sweeps away the profit. What the more intelligent of the public feel in regard to the whole question is this, that there is no likelihood of any profit in the future, and that if the system is continued, a rate-in-aid may be wanted to meet any deficiency, and this is a phase of the situation that was mooted at the Committee meeting on Friday. The present position of affairs is this, that the Council will, at a special meeting on Monday next, be asked to confirm the recommendation of the Tramways Committee, and take over the 11 miles of track already constructed; but it by no means follows that if this were carried the remaining lengths for which Parliamentary powers have been obtained would be equipped with the Lorain system. Indeed, it is now hinted that even if that system is continued in the centre of the town, the lines to the outlying districts may be equipped with the overhead trolley.

TELEGRAPH AND TELEPHONE NOTES.

American Pacific Cable.—It is reported that Mr. Root, U.S. Secretary for War, has granted permission to the Pacific Commercial Cable Co. to land its cable in the military reserve near Fort San Antonio, Abad, in the Philippines, and to erect a cable station there.

Official Vocabulary of Code Words.—From the time the Vocabulary was referred to in the International Convention Revision, 1896, a struggle has been carried on as to whether the use of the Vocabulary of Code Words should be compulsory or not, the result being so far a victory for those objecting to its adoption. Chambers of Commerce in all parts of the world, acting on behalf of the commercial community, have united in condemning the Vocabulary, with the result that the Postmaster-General has officially informed the Birmingham Chamber of Commerce that instructions have been issued to the delegates of the forthcoming Conference to object to its compulsory adoption. Those interested in codes, as far as expression has been given, are divided in their opinion as to the value of an official code, and the cable companies are in the same doubtful condition. It appears to us, however, that the whole question hinges upon the universal acceptance and proper observance by the telegraph administrations of a method of some kind. The issue of a Vocabulary would meet the case, but there appears to be no necessity for the dislocation of business which would be caused to merchants by its adoption being made compulsory, as they would have to alter and practically recompile intricate codes now in use. A little thought would probably have prevented the suggestion of such a method which, we believe, was made to overcome the use of improper words permitted in various countries and probably by various cable companies. Therefore, the question at issue appears to be a simple one: What method is there which will be equally fair to the merchant and telegraph company? And if it is brought into force by the latter will it be observed in all parts of the world by the telegraph companies? We very much doubt if the keen rivalry will permit of any settlement; but we suggest, failing a better method, that the charge for telegrams be fixed at "per letter, figure or sign or any combination thereof." We throw out this suggestion, not as a "cast-iron" one, but with the object of inviting discussion, and in such a manner arriving at a solution within a reasonable time and to eliminate the present friction. If this scheme were decided upon and a merchant made up and presented for transmission unpronounceable words, he would understand that his telegram ran a greater risk of mutilation (as it would not be repeated) than that of one who had been wise enough to give the telegraph company reasonable chances by presenting pronounceable words, and the former would have no cause for complaint by reason of neglect of ordinary precautions which he would take in any business transaction. On the other hand, if pronounceable words were tendered the sender might reasonably look for correct delivery. The present method of charging for telegrams, by reason of its intricacy, does not commend itself as a final settlement of the question if uniformity is to be looked for. The rules for charging adopted generally are as follows: viz., code words, 10 letters = 1 word; code words over 10 letters = 2 words, and so on. Ordinary words, if not in code or cypher messages, 15 letters = 1 word; cypher, 5 letters or figures = 1 word. Landlines give a rate per message. Some charge for the address and some do not, in fact, the Vocabulary, much condemned as it is at present, may after all prove a blessing in disguise inasmuch as its proposed issue may have the effect of bringing about uniformity.

The Sark Cable.—The Island of Sark has now been connected by cable with the other Channel Islands.

Telegraphic Interruptions and Repairs :—

Cables.	Interrupted.	Repaired.
Latakia-Cyprus	June 20, 1899	
Trinidad-Demerara No. 1	Aug. 27, 1901	
Dominica-Martinique	May 8, 1902	
St. Lucia-Martinique	May 8, 1902	
Guadeloupe-Martinique	May 9, 1902	
Martinique-Puerto Plata	July 10, 1902	
Guantanamo-Mole St. Nicholas	Aug. 4, 1902	
Cayenne-Pinheiro	Aug. 13, 1902	
St. Lucia-St. Vincent	Sept. 19, 1902	
Reissa-Issa	Oct. 22, 1902	
Reissa-Yemani	Oct. 22, 1902	
Paramaribo-Cayenne	Feb. 27, 1903	
Jamaica-Colon	March 12, 1903	
New York-Hait	April 13, 1903	
St. Jacques-Haiphong	April 17, 1903	
Malta-Bone	April 25, 1903	April 27

Wireless Telegraphy.—In his speech at the Institution of Mechanical Engineers' dinner on 23rd ult., Lord Selborne in referring to the British disaster in Somaliland, said that this war was the first occasion on which there had been an organised attempt to utilise Mr. Marconi's invention in warfare, and it had not succeeded. "It showed either that those who were charged with using the apparatus were not sufficiently skilled, which he thought was not probable, or that under the conditions of the country new conditions were developed which disturbed all previous calculations, and made the apparatus useless. Doubtless that would be overcome in the future, and the invention would be utilised. He could only say that at sea the use of wireless telegraphy had reached a point at which any ship which was unprovided with it considered that it had a first class grievance. It was of the utmost possible convenience, and the certainty of its use never varied. He spoke, of course, of a reasonable radius of action and of times of peace. How far it could be utilised in times of war when both combatants were possessed of the same instruments experience only could decide. The great development of wireless telegraphy in the Navy was only a fresh demonstration of the fact that every application of science to marine warfare enlarged the field of the engineer."

This speech drew a letter from the Marconi Co. to the *Times*, saying that the company had not supplied any apparatus for use in Somaliland, though Marconi apparatus might have been tried there without the company's recommendation as to its suitability for working overland under conditions likely to obtain in such a country. "Apparatus suitable for working on ships at sea is not necessarily suitable for overland work, nor is apparatus suitable for working overland in a certain country necessarily suitable for working over similar distances in other countries. The conditions under which the apparatus is required to work have to be studied specially in each case. If apparatus supplied, for example, to the Navy, is used inland, success is not merely not guaranteed, but improbable. . . . Probably in Somaliland atmospheric disturbances are frequent and would prove a source of interruption unless special devices were adopted in connection with the apparatus. . . . In the Congo Free State, where electrical storms are very frequent, our apparatus has been working successfully overland for some time past, but the apparatus has been specially designed for the purpose."

The *St. James's Gazette* says that within a few days the first consignment of Braun portable wireless telegraph carriages will be shipped from Berlin to Washington, to be employed by the United States signal corps for the Army. Six of the carriages will be sent and placed in operation at the military forts near Washington, and will be employed in manœuvres. The wagons will be especially adapted for use in the mountainous western regions of the United States. This will be the first attempt in the United States Army to employ wireless telegraphy on a practical basis. It is not unlikely that as many as 15 such carriages will be sent to the United States and used by the signal corps. Several will be shipped likewise to the Philippines for active service. Two carts are used, one containing the wireless telegraphic apparatus and the rear carriage the benzine motor. It is proposed to carry wireless messages a distance of 100 kilometres, or from 60 to 80 miles.

Experiments with the Braun-Siemens system operating between running trains were made over a section of the Berlin—Zossen military railway on April 24th.

It is stated by Mr. Arnold Foster that the present average expenditure upon wireless telegraphy in the British Navy is about £20,000 per annum.

(*Continued on page 745.*)

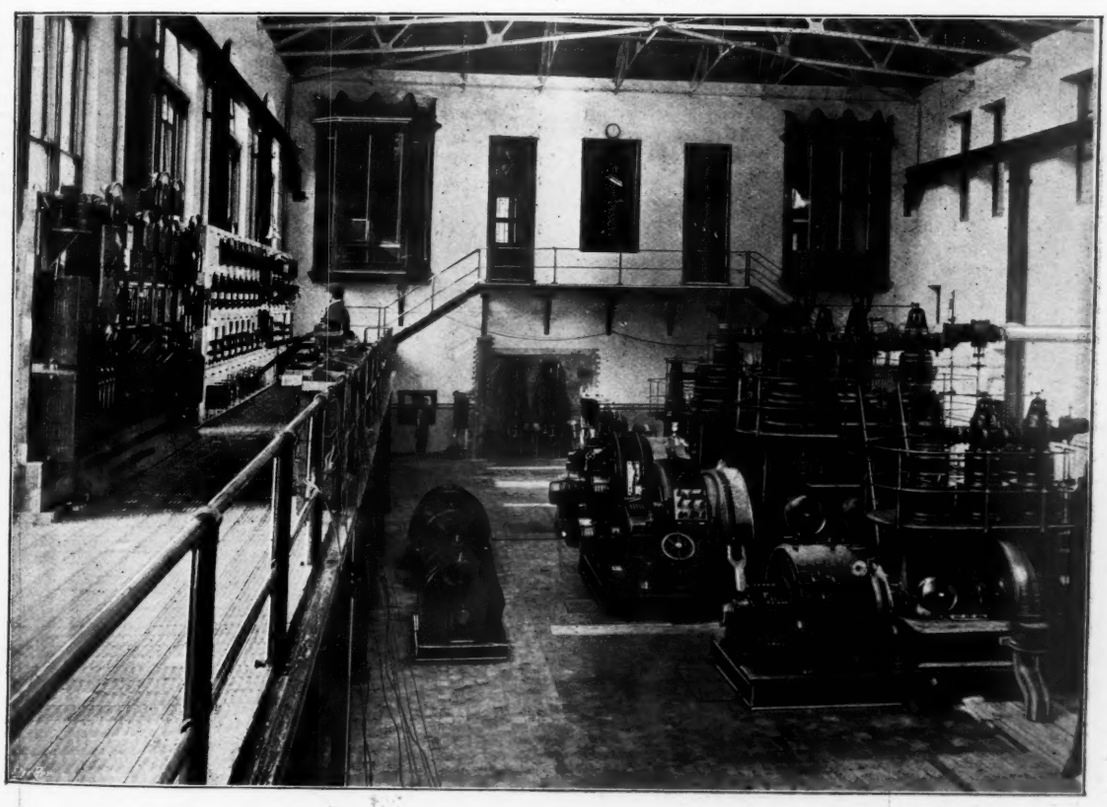
THE NEW ABERDEEN ELECTRICITY WORKS.

ABERDEEN, well known as "The Granite City," is the fourth in point of size in Scotland, having a population of 153,000 inhabitants, and an area of 6,700 acres. Aberdeen has been a royal burgh from the twelfth century, and has always been a centre of learning in the North of Scotland, its University dating back to Bishop Elphinstone's time in the fifteenth century. It was a commercial centre long before Edinburgh had acquired the precedence of a capital, and while Glasgow was yet an insignificant dependency on its bishop. It is known principally in connection with its grey granite, which is extensively exported, but as a fishing centre it is second only in the United Kingdom to Grimsby. As regards other industries, Aberdeen is not really affected by dulness in any particular trade. It is the headquarters of one of the largest paper-making works in Great Britain—viz., that of Messrs. Alexander Pirie & Son, Ltd. It has a monopoly in the manufacture of horn combs, and has also extensive manufactures in linen, cotton, woollens and tweeds. Aberdeen is a convenient centre for tourists going to the Highlands and Deeside, and in the latter district, 50 miles from Aberdeen, is situated Balmoral Castle. The city has a great historic and legendary interest, possessing one of the oldest cathedrals in the country; among other places of interest in the city may be mentioned the Brig o' Balgownie, a one-arch bridge spanning the River Don, and said to be built by Robert the Bruce.

The Aberdeen Town Council obtained a provisional order for electric lighting in the year 1890; Prof. Kennedy was appointed consulting engineer in the first instance, and he laid out the first works in Cotton Street, adjoining the gas works, from which supply was started on February 27th, 1894. In August, 1893, Mr. Ruthven Murray was appointed

FRONT VIEW OF WORKS.

city electrical engineer, and took charge of the works till February, 1895, when he resigned to go to the Worcester Corporation. He was succeeded by his assistant, Mr. Blackman,

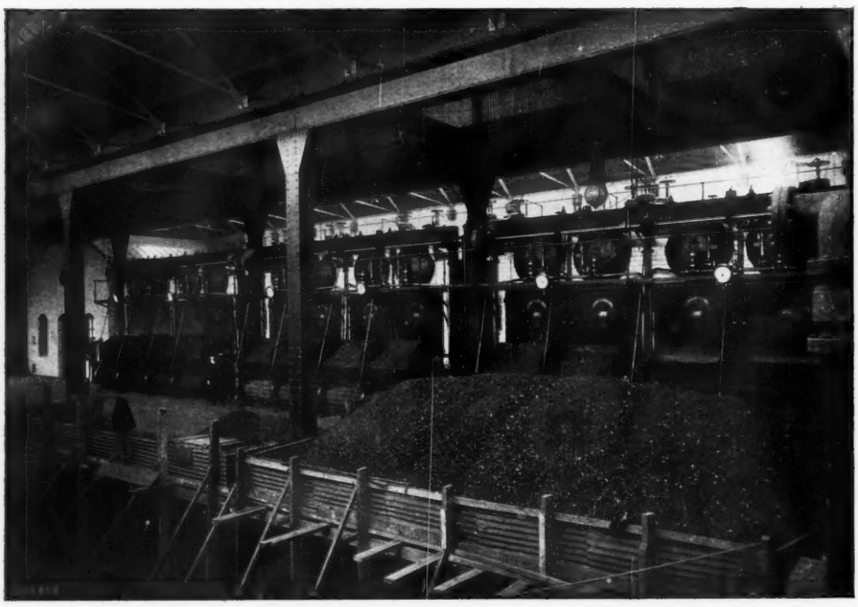


GENERAL VIEW OF ENGINE ROOM.

who was city electrical engineer from March, 1895, to June, 1898. Much of the ultimate success of the undertaking is the result of the good pioneer work done by these two engineers.

Mr. J. Alex. Bell was appointed city electrical engineer in July, 1898. In that year the area of supply was largely increased, mains being laid to the west end of the city and also along the quays of the harbour. The Harbour Board

became a consumer with the erection of about 60 arc lamps, taking power also for the working of the cranes, bridges, &c. On August 25th, 1898, the Corporation acquired the tramways from a private company, and on September 21st, 1898, the burgh surveyor and the electrical engineer were instructed to report on the electrical equipment of the Woodside route. This route was in operation by December, 1899, and it was not until 1902 that it was decided to equip the remainder of the horse tramways, which were all finished by June 1st of that year.



Interior of Boiler House.

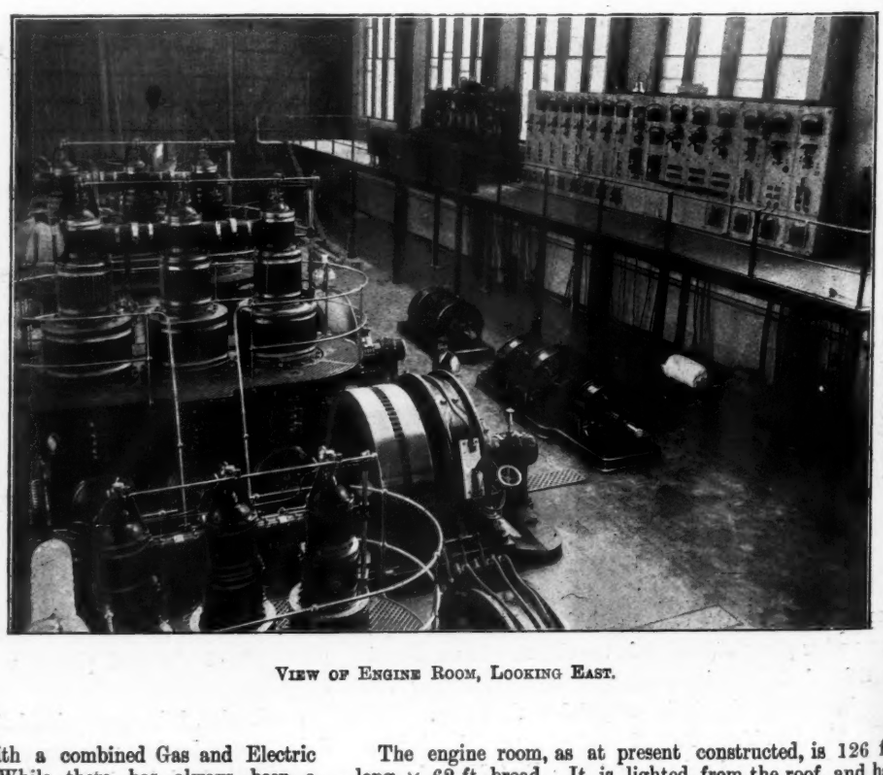
In December, 1899, Mr. Bell reported to the Gas and Electric Lighting Committee on the necessity of taking steps to acquire ground for a new generating station, as the site of the Cotton Street works was inadequate for extensions. Three new sites were suggested; after a lengthy consideration, the Council, on April 2nd, 1900, approved of the recommendation of the engineer that the Dee Village site be selected. It was not until December, 1900, that the plans were passed for the new works, and while operations had been going on in the way of clearing the site prior to that date, the contracts for the buildings were not finally let until April, 1901, although the necessary generating plant had been previously ordered.

It is interesting to note that Aberdeen is one of the few towns still remaining with a combined Gas and Electric Lighting Committee. While there has always been a friendly rivalry between the two departments, which has stimulated them both, it is to be noted that on the engineer reporting on the necessity, to his mind, of appointing some architect to supervise the stone and lime portion of the work, the gas department supplied this want in the person of the assistant gas engineer, Mr. Milne, it being rather a boast of the members of the Committee that the whole of the works were carried out by the officials of one committee, without calling in either the city architect or the burgh surveyor.

The long delay in passing the plans necessitated the erection of a temporary wooden engine room and boiler house, crane, and a temporary chimney; supply was started with these expedients on November 2nd, 1901.

The new works consist essentially of an engine room, boiler house, pump room, economiser house, and battery room, with test rooms and offices over, the whole of which buildings are constructed of granite.

The whole of the concrete foundations for the engines, boilers, and engine-room sub-floors, the erection of the switchboard, &c., were carried out by the Town Council's own employés. The iron work was done by Messrs. W. McKinnon & Co., and James Abernethy & Co., and the mason work by Mr. Leslie Smith, all of Aberdeen.



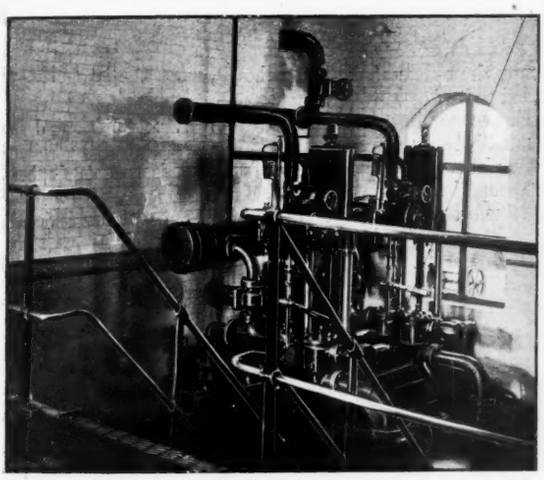
View of Engine Room, Looking East.

The engine room, as at present constructed, is 126 ft. long × 62 ft. broad. It is lighted from the roof, and has also six large windows facing Millburn Street, and 12 small

windows at the crane level above the boiler house roof. The whole of the walls are tiled, as also is the floor; the

Back of Boilers.

east end of the engine room is at present closed by a temporary wooden gable to allow for extensions.



Feed Pumps.

The generating sets are disposed in one line down the centre of the engine room; the switchboard is erected on a raised platform on the south side, and the condensing plant on the north side of the engine room, on a sub-floor, access to the latter being obtained by staircases from the main engine room floor. A 20-ton electrically-driven travelling crane, built by Messrs. J. Carrick and Sons, spans the engine room, the runways being supported on columns and girders independent of either of the engine room walls. The vacant space at the east end of the engine room, where engine foundations will eventually be placed, is at present used as a fitters' and machine shop.

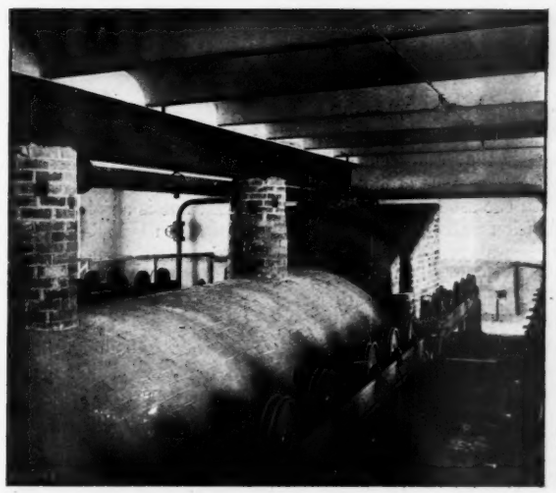
The generating sets already installed comprise two Willans-Mavor & Coulson sets, of 200-KW. capacity each; one Willans-Johnson-Lundell 420-KW. set; one Willans-Westinghouse 420-KW. set, and one Willans-Bruce Peebles set of 200-KW. capacity, the latter having been removed from the old Cotton Street Works.

These machines are compound wound, and are fitted with throw-over switches, to put in the compound winding when connected to the traction board; on the lighting circuits they are run as shunt machines. One Mavor & Coulson 60-KW. balancing set, and a Mavor & Coulson boosting set for charging the batteries, consisting of one 110-H.P. 440-volt motor, coupled direct to two 42-KW. dynamos, are also installed.

A separate condenser with air and circulating pump is provided for each pair of engines. The air-pumps, which are of the Edwards type, and the circulating pumps are direct driven by electric motors. The condensing plant was supplied by Messrs. Alley & MacLellan, of Glasgow.

The switchboard is erected on a raised gallery, consisting of cast-iron columns and girders, supporting a glass floor. There is a Westinghouse traction board, capable of dealing with the present wants of the city, and consisting of six generator panels, eight feeder panels, one load panel, and one Board of Trade panel. The lighting switchboard consists of teak panels, with the necessary instruments mounted on them for dealing with four dynamos, four circuits and the batteries. This is the temporary board which was used in the wooden engine room; it was removed practically in one piece to facilitate the work of completion.

Besides having steps leading down to the engine room, the switchboard gallery connects directly with the gallery running along the whole of the west side of the engine room,



Economiser and Bye-Pass Flue.

which gives access to the shift engineer's office and the main offices, and also leads into the boiler house.

Storage Battery.

The cables are brought up to the switchboard from the cable subway, which enters the works on the south side of the engine room.

The boiler house, which is in three bays, is 126 ft. long × 83 ft. wide, and is constructed so as to allow of two lines of boilers, one on each side of the central firing platform. In the centre bay will be situated the bunkers, to be fed by a coal conveyor. There is a sub-floor below the firing platform to which the ash shoots from the boilers are led, and in which the feed, economiser, and hot-well pipe ranges are situated. It is proposed to have an ash conveyor to deal with the ashes on this level. The main flue is adjoining the division wall between the engine room and the boiler house, and measures 7 ft. 4½ in. × 11 ft. 3 in. This flue leads to the economiser house, and provision is made for a similar flue to lead from the other range of boilers, when erected on the north side of the boiler house. At present there are erected six Babcock & Wilcox water-tube boilers, fitted with superheaters and chain grate stokers, each boiler being capable of evaporating 15,000 lbs. of water per hour.

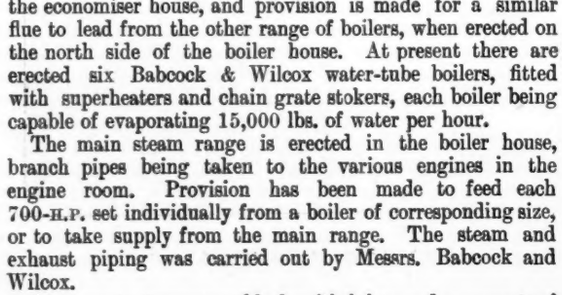
The main steam range is erected in the boiler house, branch pipes being taken to the various engines in the engine room. Provision has been made to feed each 700-H.P. set individually from a boiler of corresponding size, or to take supply from the main range. The steam and exhaust piping was carried out by Messrs. Babcock and Wilcox.

At present a temporary blacksmiths' shop and a carpenters' shop are erected on a space to be occupied by boilers at some future time.

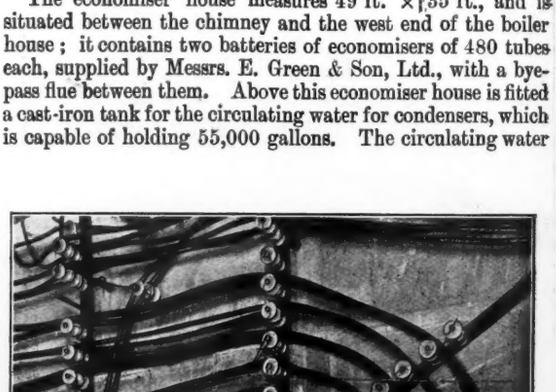
The pump room is a glazed brick house at the end of the battery of six boilers, and contains at present two of Messrs. G. and J. Weir's feed pumps, capable of pumping 4,000 gallons of water per hour. Below the pump room floor is a concrete tank, capable of holding over 100 tons of water, and the pumps can lift from either this tank or the hot-well, which is situated in the yard. This pump room will occupy the centre of the boiler house, when the latter is extended to its full capacity.

The economiser house measures 49 ft. × 35 ft., and is situated between the chimney and the west end of the boiler house; it contains two batteries of economisers of 480 tubes each, supplied by Messrs. E. Green & Son, Ltd., with a bye-pass flue between them. Above this economiser house is fitted a cast-iron tank for the circulating water for condensers, which is capable of holding 55,000 gallons. The circulating water is to be obtained from the River Dee, which is situated 350 yds. from the works. Through the works grounds there is a concrete culvert 6 ft. high and 6 ft. 6 in. wide, which encloses a burn running through the works and also acts as a storm water culvert for the town. This runs down

Sectional Elevation of Works.



Interior of Cable Subway.



Entrance to Cable Subway.

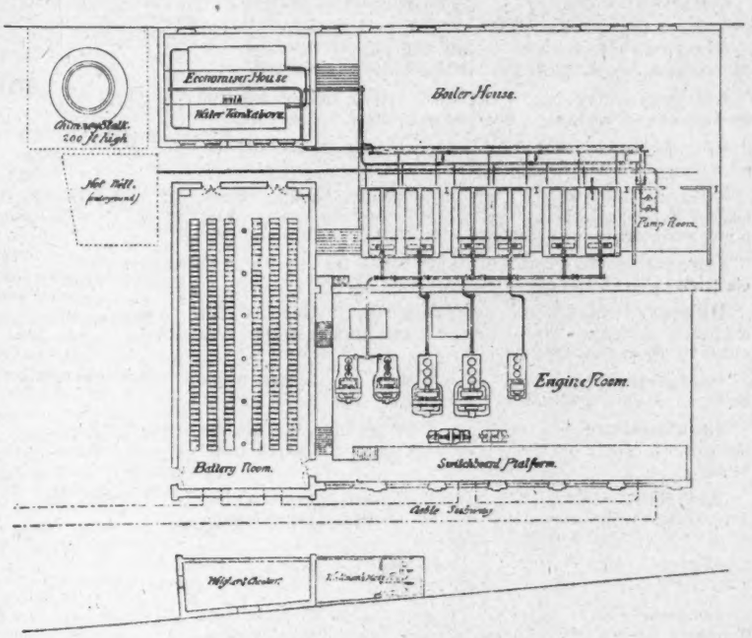
to the River Dee. After making observations for 11 months on the quantity of water passing down this burn, and in view of some being used at the Bleachfields, above the works, it was not thought expedient to use this water for condensing purposes. It was, therefore, decided to carry an 18-in. pipe in the burn down to the pump chamber at the River Dee, where an electric motor-driven centrifugal pump will lift water to the works, either direct to the condensers or to the water-tank above the economiser house.

The chimney is 210 ft. high × 14 ft. inside diameter for its entire height, and was erected by Messrs. Gall & Walker, of Aberdeen. Up the centre of the chimney is placed a 24-in. cast-iron exhaust pipe, which is used for exhaust steam when non-condensing. The size and design of the chimney were the cause of a good deal of discussion in the Town Council, it being originally intended to erect an octagonal chimney of the same capacity as that at present installed, with Ruabon bricks and buff panels. It was decided to spend so much on the elaboration of the buildings to preserve the amenities of the district that it was thought by many that for an additional £500 the chimney should be made as ornamental as possible. This proposal was, however, defeated, and while the works possesses a chimney which is quite suitable for all its requirements, a great number of the Town Council now regret that they did not make it a little more ornamental.

The battery room is 98 ft. long × 44½ ft. wide, and at present contains two E.P.S. batteries, capable of giving a discharge of 2,200 amperes at 220 volts. A light hand-driven crane is erected over each battery for handling the cells, and there is a jib crane outside the two large doors to unload material from lorries outside. Two large enamelled sinks are provided for cleaning purposes. Underneath the battery room is a workshop used in connection with the mains and services department.

The offices are all on the first floor above the battery room, with the exception of the weigh-house and time-checking department, which are situated on the ground floor of the tower at the Millburn Street end of the works. They consist of a waiting room, drawing office, general office, chief clerk's office, chief engineer's office, shift engineer's office, station engineer's office, mains superintendent's office and test room, with the necessary lavatory accommodation. At the north end of the block is a large room, which was intended for a lamp store and motor testing department only, access being gained to this either from the office passage, or from the yard, by means of a staircase. As the Council had not at that time decided whether the car repair sheds should occupy the space which was left in front of the ground for the purpose, it was necessary to erect temporary stores for the whole of the works in this room, besides using it as a motor-testing department.

The cable subway, which extends from the works *viâ* Crown Street to a point 180 ft. from Union Street, the main street of the city, is 2,480 ft. long, and its average dimensions are 7 ft. 6 in. high × 4 ft. 6 in. broad. It is fitted with cast-iron racks at intervals of 6 ft. Into these racks pins are screwed, which carry insulators to hold the cables. At present the subway contains 13 feeder and test cables for tramways, and 15 for lighting. All the cables at present erected in this subway are merely insulated with duplex braiding, and taped; if required, bare copper strip can be used with perfect safety. It is electrically lighted throughout, and at the cable chamber in the end is fitted an electrically-driven fan, which is controlled from the works, and is run for an hour or two daily to draw in warm air out of the engine room and keep everything dry. This cable subway was built over the main sewer, and at the same time as the Burgh Surveyor's Department were constructing the latter down Crown Street. It is constructed of concrete, and has a bitumen sheeting course between the concrete and the brick lining. It was designed to carry cables suitable for 10,000 H.P. low-pressure supply, but it is capable of extensions to 15,000 H.P. The subway was built by Mr. P. Tawse, of Aberdeen.



PLAN OF DEE VILLAGE WORKS.

In conclusion, our acknowledgments are due to Mr. J. Alex. Bell, the city electrical engineer, for his kind help in the preparation of this article.

TELEGRAPH AND TELEPHONE NOTES.

(*Continued from page 740.*)

Pacific Cable.—On April 27th there was an animated discussion in the Canadian Senate on the subject of the Pacific cable. The *Times* correspondent at Ottawa says that Sir M. Bowell initiated the debate, and warmly approved Sir Wilfrid Laurier's efforts to induce the Australian Commonwealth not to grant further privileges to the Eastern Extension Co. He said that the management of the Pacific Cable seemed to be lacking in business energy. They should appoint agents to secure business in every part of Australia. Mr. Scott, replying for the Government, said that those who had followed the efforts made to strangle or paralyse the project must have felt their patriotism and desire for the Imperial connection somewhat chilled. The Dominion had endorsed the enterprise from Imperial motives alone. Had Canada known the difficulties which would be thrown in her way during these six years, it was doubtful whether she would have gone into management with the mother country and the Colonies. He expressed profound regret that New South Wales should have deliberately broken her share of the contract. The Canadian Government had recently strongly protested against the proposed 10 years' agreement between the Commonwealth and the Eastern Extension Co., by which the latter practically secured a monopoly of cable business. There the matter rested for the present, except that the proposal for a limited free press service had been rejected by the Commonwealth, on the absurd ground that it could not see that any object would be gained.

CONTRACTS OPEN AND CLOSED.

OPEN.

Basingstoke. — May 8th. The Corporation invites tenders for a 21 years' lease of the electric lighting order. See "Official Notices" April 24th.

Belgium.—May 29th. Tenders are being invited until May 29th by the municipal authorities of Charleroi for the electric lighting of the town. Tenders are to be sent to l'Hotel de Ville, Charleroi, whence particulars may be obtained.

Brighton.—June 8th. The Council wants tenders for 5,400 KW. generating plant at Southwick power station, and 5,000 KW. motor-generator converting plant, together with switchboards, instruments, &c., at North Road power station. See "Official Notices" April 17th.

Cairo (Egypt).—May 12th. The Egyptian Government is inviting tenders for an installation for the transmission of power for public and private purposes at Ghiza and Jhezira. See this column for April 3rd.

Coventry.—May 6th. Two 8 ft. 6 in. × 30 ft. Lancashire boilers. See "Official Notices" April 24th.

Edinburgh.—May 4th. Electricity meters (12 months' supply). See "Official Notices" April 17th.

Felixstowe.—May 16th. Cables, arc lamps and poles, for the U.D.C. See "Official Notices" to-day.

Glasgow.—May 4th. Cables, meters, carbons, &c., for the electrical department. See "Official Notices" April 10th.

Glasgow.—May 5th. Carbons, rubber cables, &c., for the electricity department. See "Official Notices" April 17th.

Govan.—May 8th. Stores for the electricity department. See "Official Notices" to-day.

Govan.—May 18th. Steam dynamos, boilers, superheaters, stokers, economiser, cooling tower and condensing plant, piping and electric crane. See "Official Notices" to-day.

Hornsey.—May 11th. Joint boxes for the U.D.C. electricity works. See our "Official Notices" to-day.

Hungary.—May 31st. Tenders are invited by the municipal authorities of Veszprem for the lighting of the town either by gas or electricity.

Islington.—May 27th. Alternating current transformers. See "Official Notices" April 24th.

Johannesburg.—June 8th. Rails, points and crossings, tie-bars, &c., for the electric tramways. See "Official Notices" to-day.

Kettering.—May 1st. Boilers, engines, dynamos, battery, switchboard, lamps, mains, &c., for electric lighting installation. See "Official Notices" April 3rd.

Leyton.—May 13th. Low-tension cables. See "Official Notices" April 24th.

London.—May 4th. Electric wiring at the Bow Road Infirmary for the City of London Union. See "Official Notices" April 24th.

Rangoon.—July 1st. The Municipal Committee wants tenders for carrying out its electric lighting license, and particulars, forms, &c., can be obtained from the officiating secretary (W. Shircore), Rangoon municipality, at Rs. 75 per set.

Sheffield.—May 2nd. Piping and high-tension switchboard for the Neepsend new power station. See "Official Notices" April 17th.

Stockport.—May 13th. Steel structural work for the Millgate electricity station. See "Official Notices" April 24th.

Sunderland.—May 4th. Electric tramway stores. See "Official Notices" April 24th.

Willesden.—May 12th. Arc lamp carbons for the electricity department. See "Official Notices" to-day.

CLOSED.

Batley.—The Traction Committee of the T.C. has accepted the tender of the British Westinghouse Co. for the supply of eight tramcars.

Blackpool.—The T.C. has accepted the tender of Messrs. Mather & Platt for the supply of engines and dynamo in connection with the utilisation of the waste heat at the refuse destructor works.

Bristol.—The Corporation Electricity Committee on Friday accepted the following tenders:—Messrs. Wilkins & Sons, for sub-stations; Brush Electrical Engineering Co., for motors for the Avondale Works; Messrs. Askham Bros. & Wilson, for coal conveying plant; British Westinghouse for pipe work and mains; Messrs. McDowall, Stevens & Co., for arc lamp standards.

Cleckheaton.—The U.D.C. has accepted the tender of Messrs. W. T. Glover & Co., for the supply and fixing of traction and pilot cables.

Finchley.—The U.D.C. has given the contract for piping to Babcock & Wilcox at £3,450; that for the switchboard work at £2,046 going to Messrs. Kelvin & James White, Ltd.

Hackney.—The E.L. Committee received the following tenders for condensing plant:—Bertrams, Ltd. (alternative with German motor) £2,366; Richardsons, Westgarth & Co., Ltd., £2,438; Ashton, Frost & Co., Ltd., £2,445; Alley & MacLellan, £2,471; Bertrams, Ltd., £2,656; Pulsometer Engineering Co., Ltd., £2,681; Cole, Marchent & Morley, Ltd., £2,758. Acting upon the advice of the consulting engineer, the Committee has decided in favour of the tender of Messrs. Richardsons, Westgarth & Co.

Lowestoft.—The British Thomson-Houston Co. have sublet the contract for an 825-H.P. engine to Willans & Robinson, Ltd. This new set is intended for supplying power to the tramways.

Southampton.—The T.C. has accepted the tender of Messrs. Wm. Griffiths & Co., Ltd., for Jarrah wood blocks for the tramway route.

Trafford Park.—Messrs. Browett, Lindley & Co., Ltd., have secured the order for a 300-kw. combined set for the Trafford Power and Light Supply, Ltd. This is the second order received by the firm for this station. The order for the generator has been sublet to the Lancashire Dynamo & Motor Co., Ltd.

FORTHCOMING EVENTS.

Friday, May 1st.—At 9 p.m. Royal Institution. Discourse by Prof. W. J. Pope, F.R.S., on "Recent Advances in Stereo-Chemistry." [Annual meeting at 5 p.m.]

Incorporated Society of Inspectors of Weights and Measures. Annual General Meeting at Spring Gardens, S.W. Paper on "The Metric System," by Mr. Alexander Siemens.

Saturday, May 2nd.—I.E.E. (Students). Visit to the works of the Western Electric Co., Woolwich.

Monday, May 4th.—At 8 p.m. Society of Arts. "Mechanical Road Vehicles," by W. Worby Beaumont. (Cantor Lecture No. II.)

Wednesday, May 6th.—At 7.30 p.m. I.E.E. (Students' Section), 92, Victoria Street, S.W. Paper to be read: "Synchronous Electrical Machinery," by J. D. Griffin.

At noon. International Fire Exhibition opens at Earl's Court. The Duke of Cambridge performs the ceremony.

Thursday, May 7th.—At 5 p.m. Royal Institution. Prof. Dewar on "Hydrogen: Gaseous, Liquid and Solid." (Lecture III.)

At 8 p.m. Civil and Mechanical Engineers' Society. "On the Choice of Steam Boilers," by C. E. Stromeyer.

At 8.30 p.m. Röntgen Society. Exhibition of various new forms of apparatus, including the Cooper-Hewitt (mercury vapour) lamp, to be shown by the British Westinghouse Co.

I.E.E. Extra meeting. In the event of the discussion on Mr. Aitken's paper, "Divided Multiple Switchboards," being concluded at last night's meeting, the following papers will be read and discussed on May 7th:—"Applications of Electricity in Engineering and Shipbuilding Works," by A. D. Williamson; and "Electric Driving in Machine Shops," by A. B. Chatwood.

NOTES.

The Conductivity of Air.—Elster and Geitel (*Phy. Zeit.* 2, pp. 116—119, 1900) first drew attention to the fact that the conductivity of a mass of air confined in an airtight chamber gradually increases. In a subsequent investigation (*Phy. Zeit.* 2, pp. 560—563, 1901) they found that the air in caves and house cellars had an abnormally high conductivity. They traced these phenomena to the existence of some undetermined radio-activity on the confining walls. More recently they found that a negatively-charged conductor exposed to the air for some time became radio-active. McLennan and Burton describe (*Physical Review*, March, 1903, p. 184) some interesting experiments on this subject, in which they show among other things that the conductivity of air in closed vessels depends on the metal forming the sides of the vessel. Vessels with zinc, tin and lead sides were tried. The final conductivity induced in the air by the influence of the sides was found to be in the order of the atomic weights of the metals—*i.e.*, it was least with zinc and greatest with lead. Now, it is significant that all the strongly radio-active metals, such as radium and thorium, have very high atomic weights. These experiments of McLennan and Burton point to the conclusion that all metals may be more or less radio-active, and the radio-activity increases with the atomic weight. Certain phenomena observed by McLennan and Burton appear to indicate that the sides of the vessel also give off an emanation like that given off by thorium and radium. When fresh air is first shut up in the closed vessel its conductivity is high, then it falls gradually to a steady value. This is explained upon the hypothesis that a radio-active emanation, probably having its origin in the earth's surface was introduced into the cylinder with the air, the decay of this emanation being the cause of the decrease in the conductivity. The subsequent increase of the conductivity would be due to an emanation given off by the walls of the vessel. This explanation does not appear to be very satisfactory. There appears to be no direct evidence of the existence of any emanation in this case other than the cathode or other rays thrown off by the walls of the vessel and the earth. In addition to the radiation from the sides of the vessel, a highly penetrative radiation from the earth has been shown to pass through the sides of a closed vessel, and influence the conductivity of the contained air. When the vessel containing the air was immersed in water so as to screen off radiation from external sources, the conductivity of the air in the vessel was reduced by 30 to 40 per cent. A similar reduction of conductivity was effected by surrounding the closed vessel with thick masses of lead. The influence of the permanent negative charge of the earth must not be forgotten in

trying to account for this mysterious radiation from its surface. The earth is in the same condition as Elster and Geitel's negatively charged wire, and we should expect it to be radio-active for the same reason.

The Value of Latin in Schools.—Some interesting remarks upon the value of Latin as an ingredient of the ordinary scholastic course are to be found in the address delivered to the Institute of Chemistry of Great Britain and Ireland by Prof. J. Millar Thomson, LL.D., F.R.S., the retiring President, at the twenty-fifth annual general meeting of that body held last month. Prof. Thomson, as is probably well known, is the Professor of Chemistry in King's College, London, and as such he must naturally tend to approach the question of teaching Latin rather from the pedagogue's standpoint. In one part of his address Prof. Thomson was dealing with the examinations which students who desire to possess the qualifications given by the Institute have to undergo; and he observed that the preliminary examination into general education which is properly insisted on "Still gives us a certain amount of trouble. Classics are more and more discouraged in schools, and thus the inclusion of Latin as a compulsory subject in the preliminary examination [held by the Institute itself] is often a hardship. On this point there has been much deliberation, and will, no doubt, be much more. Apparently, from what I have been able to gather, and from opinions expressed to me personally, the professorial element is for the most part in favour of Latin being made optional, or alternative with a modern language, but the practising or technical elements appear to favour its retention as a compulsory subject." Prof. Thomson is clearly reluctant to give up his Latin, but he feels that the example set by the Universities in respect of science and engineering students is rather forcing the hands of the Institute, and he admits that the question of utility has to be considered with the question of general culture. The idea that the professors are against, and practical men for, Latin is somewhat novel, for it is usually assumed, with some cynicism, that schoolmasters desire the retention of that language because it is easy to teach, or because they have acquired facility in teaching it more or less automatically by life-long practice. It must surely be easier for, and more satisfactory to, a teacher to teach an exact subject than an experimental one, even admitting him to have the energy, ability and leisure to keep himself abreast of advances in the experimental one. Whatever may be said to the contrary, it must require almost exceptional tact and skill on the part of an instructor to preserve his pupils' attention and respect when he is explaining theories which he himself knows may be proved incorrect to-morrow, or when he is conducting experiments which really demonstrate something different from what is usually attributed to them. The experienced adult may readily realise the truth of the dictum that the more a teacher knows, the less he is willing to admit that he does know; but this is a habit of mind hardly characteristic of healthy, irreverent British schoolboys in general. Prof. Thomson makes no suggestion as to why practising and technical chemists seem to favour the retention of Latin as a compulsory subject of instruction. They do not use the language to any appreciable extent in their daily work, and therefore they can only have some vague notion that it has been of service to them in some indirect fashion. Modern foreign languages are, of course, of immense value to any man of science, especially German and French; but it must be admitted that the kind of German and French needed by the student of science is very different from that taught in schools, being entirely distinct in vocabulary, and occasionally written so hurriedly as to be difficult of comprehension, even by a member of the nation concerned. Complaints are frequently made about the terrible English employed by numerous technical writers in this country, but similar remarks will often be found in German journals; and the lot of him who has to read through and thoroughly master such articles in a foreign tongue is by no means to be envied.

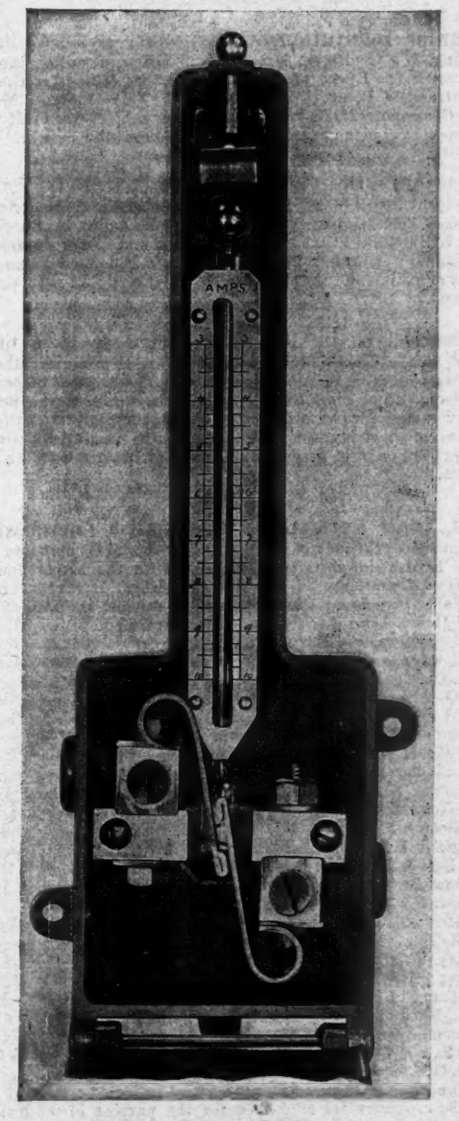
Lectures.—A lecture on "The Polyphase System of Electric Currents for Light and Power," was delivered in the Lecture Theatre of the Royal Dublin Society, on Thursday last week, by the Right Rev. Monsignor Molloy, D.D., D.Sc. The object in view was to give some idea of the nature of polyphase currents, to show how they were used to drive electric motors, and to explain the grounds on which the system had been selected for the City of Dublin. The new electric installation of Dublin, which is now approaching completion at the Pigeon House, is expected to be opened in a few months.

At a meeting of the Cork Scientific Association on April 24th, Mr. J. Comerton, B.A., gave a demonstration of the action of the "Nernst Lamp."

The German Bunsen Society.—The German Bunsen Society for Applied Physical Chemistry will this year hold its annual meeting in connection with the International Congress of Applied Chemistry, which is to take place from June 2nd to the 8th. The Bunsen Society will meet on June 4th, and no fewer than 32 papers, mostly on electro-chemical subjects, have already been promised.

Composition.—At Ashton-under-Lyne on April 23rd Judge Brown, K.C., was asked to approve of a composition proposed by John Phillips Bedson, managing director of the Clayton Engineering Electrical Construction Co., Ltd., of Hyde, by which the creditors will be paid in full, with 4 per cent. per annum interest. The annulment of Mr. Bedson's bankruptcy was also applied for. The Official Receiver (Mr. C. J. Dibb) said that if the estate was wound up in bankruptcy, it would probably pay only 2s. 6d. in the pound. The Judge made the orders asked for.

Fricker's Patent Maximum Demand Indicator.—A maximum demand indicator working on a novel principle is being introduced by Messrs. Fricker & Miller, of 82, Victoria Street, Westminster, S.W. The instrument is a differential thermometer, in which a drop of mercury, contained in a glass tube with a bulb at either end, is caused to act both as a gas valve and registering index of the maximum difference of temperature to which the bulbs have been subjected. In setting the instrument, the drop of mercury is shaken down into the upper spherical bulb, the tube being removable. The tube being replaced, the drop remains in the neck



Fricker Demand Indicator.

of the tube, which is of small bore. The lower bulb is closely embraced by a helical heating resistance wire connected to the terminals by two spring blades which tend to tighten it on to the glass bulb. The grip of the helix on the bulb can be released by means of a wedge key. In operation, the expansion of the gas in the lower bulb due to heating causes a definite transference of gas, through the drop of mercury acting as a valve, into the upper bulb. The amount corresponding to any given current, the removal of the thermometer, or breaking of the circuit, causes the gases in the lower bulb to cool and contract, the mercury drop travelling down the tube, a distance proportional to the total volume of gas originally transferred during the heating process. A fixed scale, marked in amperes at the side of the tube, indicates according to the position of the mercury the maximum current passed through the helix. A special feature in the design is that, should the helix get burnt out or fractured, the spring terminal blades to which it is attached instantly close together and short-circuit the instrument, preventing a failure in the service. The heating action is gradual, taking some 10 minutes to attain its full effect, but on removing the tube the temperature of the two bulbs can be equalised by grasping them in the hands for a minute or so. The consumer can read the maximum demand at any time before the current is switched on, as the mercury returns to the corresponding position after the current has been switched off. The instrument is compact in design, and is protected by a cast-iron case.

National Physical Laboratory.—The committee have recently made two further appointments to the staff of the laboratory. Mr. C. C. Paterson has been appointed to take charge of the electro-technical work, including photometry. Mr. Paterson was for a time a pupil at the Finsbury Technical College. After a works apprenticeship with a London firm and experience as a fitter in a Glasgow workshop, he became an assistant in the standardising department at Faraday House. For the last nine months he has been in the employ of the Maschinen Fabrik Oerlikon, working for some time at the three-phase motors and boring plant on the Jungfrau railway, and for the last six months in the testing department at Zürich.

Junior Institution of Engineers.—At last Friday's meeting, the Chairman, Mr. Kenneth Gray, presiding, the paper read was "The Effect of Design on Methods of Construction, from a Contractor's Point of View," by Mr. R. W. Newman, A.M.I.C.E., Vice-Chairman of the Institution. The subject was dealt with in very practical manner, and an animated discussion ensued.

Radium.—On Friday, April 17th, at New York, the American Institute of Electrical Engineers and the American Electro-Chemical Society held a joint meeting to hear a paper by Mr. William J. Hammer on "Radium and Other Radio-Active Substances and Certain Phosphorescent and Fluorescent Substances. The Properties and Applications of Selenium. The Treatment of Diseases by Ultra-Violet Rays."

Electricians in the Navy.—In reply to a question asked in the House of Commons by Mr. Kearley, whether men holding the rating of plumber or plumber's mate will be permitted to change it to electrician provided they possess the necessary qualifications, Mr. Arnold-Forster stated that, so long as the direct entries of electricians continue sufficient to meet all requirements, it is not intended to permit transfers from other ratings within the service.

St. Louis Exposition: The British Commission.—The names of the members of the British Royal Commission to look after British interests in connection with the Exposition at St. Louis next year, are as follows:—His Royal Highness the Prince of Wales, president; Viscount Peel, chairman; the Earl of Jersey, Earl Howe, Lord Castletown, Lord Inverclyde, Lord Alverstone, Lord Avebury, Mr. Horace Plunkett, Vice-President of the Department of Agricultural and Technical Instruction for Ireland; the Hon. Charles Napier Lawrence, the Hon. Sir Charles W. Fremantle, Sir G. Hayter Chubb, Sir Edward J. Poynter, President of the Royal Academy; Sir C. Rivers Wilson, Sir E. Maunde Thompson, Director and Principal Librarian of the British Museum; Sir William H. Preece, Sir W. T. Thiselton Dyer, Sir Herbert Jekyll, one of the Assistant Secretaries to the Board of Trade; Sir Lawrence Alma-Tadema, R.A., Sir C. Purdon Clarke, Director of the Victoria and Albert Museum (Art Museum), South Kensington; Sir George T. Livesey, Mr. Henry H. S. Cunynghame, one of the Assistant Under-Secretaries of State for the Home Department; Mr. Edwin A. Abbey, R.A., Mr. Charles Vernon Boys, F.R.S., Mr. Thomas Brock, R.A., Mr. George Donaldson, Mr. Clement Le Neve Foster, F.R.S., Professor of Mining at the Royal School of Mines, London; Mr. John C. Hawkshaw, President of the Institution of Civil Engineers; Mr. Thomas G. Jackson, R.A.; Mr. W. Henry Maw, President of the Institution of Mechanical Engineers; Mr. Francis G. Ogilvie, Director of the Edinburgh Museum of Science and Art; Mr. William Q. Orchardson, R.A., Mr. Boverton Redwood, F.R.S., of Edinburgh; Mr. Alfred G. Salamon, Mr. Joseph W. Swan, F.R.S., Mr. J. J. Harris Teall, F.R.S., and Mr. Francis W. Webb. Colonel Charles Moore Watson, C.B., C.M.G., is appointed secretary to the Commission.

The British Government has decided to include a sum of £30,000 in the estimates for 1903-1904 for the purpose of the Exhibition. A further amount will be provided when the requirements are ascertained. The office of the Commission is at 47, Victoria Street, S.W.

Theory of X-Ray Action on Cancer.—"Many theories have been advanced as to the action of the X-ray in the various conditions for which it has been used. By some the belief is held that restitution of the tissues takes place under X-ray treatment; that is, cancer tissue becomes transformed or is developed into normal tissue. Others, taking for granted that the parasitic or bacterial theories of the origin of some of the diseases treated by the X-ray have been conclusively proven, believe that the X-ray, due to its actinic action, destroys these conditions. These theories seem rather far-fetched, however, for, aside from the lack of proof of the parasitic or bacterial origin of the diseases referred to, it does not seem probable, from observations which have been made by various investigators, that the success of the X-ray treatment in these diseases is exclusively due to any bactericidal power which the rays may possess." The New York *Electrical Review*, after making these remarks, proceeds to quote the view expressed by Dr. E. H. Grube, in the *Medical Record*. Dr. Grube says:—"Personally, we believe the action of the X-ray is the same in all the diseases in which it has been found of value, and also that that action is most plausibly explained when viewed from the standpoint of the theory of phagocytosis followed by leucocytolysis. First, it must be admitted that, aside from whatever chemical or electrical property the X-ray may possess, the sum total of its action is that of an irritant. Now if we irritate a certain part of the body by making frequent X-ray exposures, we produce ultimately a simple focal inflammation. Inflammation means the determination of much blood to the part, hyperæmia. Due to the increased volume of blood, leucocytes accumulate in large quantities and, finally, stasis occurs, the circulation being cut off, the part dies for want of nourishment. When no suitable nutritive material is at hand there is developed a tendency toward degeneration. No doubt this degeneration is partly, at least, due to an accumulation of the products of the metabolism of cells. Primarily, then, the X-ray affects the essential tissue-forming elements of the body. The parts which are walled off decompose chemically and are either discharged or absorbed. The rapid decrease in the size of some growths under X-ray treatment also points to a more general or systemic action, probably due to stimulation of the lymphatics. The fact that nearly every case, no matter how severe, treated by the X-ray seems to improve at the beginning of the treatment, shows that it exerts an influence which is not only local but also systemic. From our personal observations upon several hundred patients we have come to the conclusion that the nutrition of the entire system is affected, through reflex action probably, and this produces a general stimulating and tonic effect. We do believe that the X-ray has established for itself a field in the therapeutics of lupus and epithelioma. Not only that, but the future will see its greatest application in the treatment of patients immediately after operation, to prevent the possibility of recurrence. The X-ray becomes a danger in the hands of the incompetent operator. We must not forget that we have a great variety of X-rays to deal with—in fact, to use a comparison, the variation in quantity and quality of X-rays obtainable with one piece of apparatus is much greater than all the varieties and qualities of tones which may be produced upon the keyboard of a piano. Again, different tissues demand different degrees of X-ray value."

Electrical Developments in Russia.—Owing to the lack until recently of electro-technical schools in Russia, the electrical industry there has not made the progress that it has in other countries. Recently the Special Art and Artizan Schools have now added electrical courses to their programmes, and the Government, private companies and individuals have opened special schools for electricians. The influence of these has been already manifested, and of late immense progress has been made. There are, however, only two dynamo factories in Russia, which are quite incapable of meeting the demand, and, in consequence, most of the electrical machinery is imported. According to an article by T. E. Heenan in the April number of *Cassier's Magazine* Germany and Switzerland furnish the greatest quantity; next comes Great Britain, and then follow the United States, France and Belgium. In St. Petersburg at the present time the combined power of the public lighting stations, including extensions now in progress, is 30,000 KW. In addition, there are about 300 private stations, having a total capacity of 39,000 KW. Continuous current is the rule, and storage batteries having an aggregate capacity of 50,000 ampere-hours are installed; but the largest stations generate alternating current, one being a three-phase station. In Moscow and other towns considerable progress has been made. The earlier stations were designed for continuous current, but latterly preference is shown for alternating. Electric tramways are also coming largely into use. Kief was the first town to adopt electric traction in 1893, and five years later 45 towns were so equipped. The system at St. Petersburg will have 400 motor-cars and 300 trailers. Schemes for the adoption of electricity on the great railways are also under consideration, together with the construction of a new electric railroad connecting neighbouring towns on the western frontier of Russia, and the establishment of a road to cross the Caucasus Mountains. No long-distance power schemes have yet been put down, but projects to use the falls of Marva and Imatra are under consideration, as is also a scheme to supply power to St. Petersburg from the Volhav rapids, over a distance of 188 miles. The electro-chemical industry is interwoven with the utilisation of water-power, and several establishments exist in the Ural and Caucasus districts, the works of Siemens Bros. producing 500 tons. With such developments going on, there should be a good field for English manufacturers. Measuring instruments and incandescent lamps are scarcely made at all in Russia, whilst Siemens & Halske have practically the monopoly in the manufacture of machinery.

I.E.E. (Manchester Section).—The annual general meeting of the Manchester Section of the Institution of Electrical Engineers was held at Owens College on Tuesday last week, Mr. H. A. Earle occupied the chair. Mr. A. P. Ramage, the honorary secretary, read the report, which showed that the total membership of the section was 472 as compared with 415 a year ago. The past session had been a successful one, and the attendance at each of the nine ordinary meetings which had been held averaged over 100. The report, which was adopted, further stated that no definite steps had yet been taken for establishing a central institution in which the various scientific societies of Manchester could hold their meetings. The question, however, was still under the consideration of the Committee. The ballot for the officers for the ensuing year resulted in the election of Mr. E. W. Cowan as chairman; Mr. C. D. Taite, vice-chairman; and Dr. F. H. Bowman, Dr. C. H. Lees, Dr. W. G. Rhodes, Messrs. A. A. Day, R. S. Downe, W. P. J. Fawcus, A. H. Gibbings, A. S. Giles, A. Bromley-Holmes, H. Lindley, G. F. Metzger, and F. H. Royce, as committee.

Appointments Vacant.—An assistant resident engineer is required at Middlesex Hospital; three charge engineers are wanted for the Willesden electricity department. See "Official Notices" to-day.

Electricity in Mines Committee.—Since our report of the evidence given last week by Mr. Selby-Bigge before this Committee went to press, we learn that the meeting held on Wednesday, April 29th, was devoted to a refutation of some of that gentleman's remarks by one who, it seems to us, ought to know the real facts of the matter. We gather from the *Times* summary that Mr. W. C. Mountain, of the well-known firm of Ernest Scott and Mountain, of Newcastle-on-Tyne, which has, we suppose, done more electrical mining work in England than any other single manufacturer, repudiated statements made by Mr. Selby-Bigge to the effect that if anyone wanted large generators he must go to the Continent of Europe or America for them. He did not think that Mr. Bigge was quite fair to the English manufacturers of electrical machinery in making those remarks, for there were firms in this country making as good generators as the Germans or Americans could turn out. He had been through the German works and had seen the particular generators to which Mr. Bigge referred, and he found that the principal reason for those generators being made in Germany was because English manufacturers were too busy and were not prepared to take them at the price at which the foreigners took them.

Foote & Milne v. St. Helens Cable Co.—This case, which is before Mr. Verey, Official Referee in London, is an action in which plaintiffs claim about £6,000 from defendant company, for expenses incurred, and damage sustained to reputation, because of alleged defective cables supplied to them. The hearing commenced on April 28th, and promises to last for some days.

Personal.—Mr. Fred Schofield has been appointed to succeed Mr. C. W. Shepherd, as tramway traffic superintendent at Bradford.

Turbine Set for Birmingham.—Messrs. C. A. Parsons and Co. have received an order from the Birmingham Corporation for the supply of one 500-kw. continuous current turbo-dynamo, 460 to 530 volts, for delivery in September next.

THE CENTRAL STATION ENGINEER.

Mr. F. Stewart has severed his connection with the Blackpool and Fleetwood Tramroad Co., and has been appointed to a like position in the power department of the Manchester Corporation Electricity Works.

On Friday Mansfield T.C. appointed Mr. Bernard Sankey, of Walthamstow, as chief engineer of the electricity works at a salary of £140 per annum, and Mr. James A. Sykes, of Rhyl, as shift engineer.

Mr. T. Cooper, A.M.I.C.E., of the Chelsea Electricity Supply Co., Ltd., has been appointed first assistant engineer to the Metropolitan Asylums Board.

Mr. P. MacAlister, of Croydon Corporation electricity department, has been appointed mains superintendent to the Battersea Council.

NEW COMPANY REGISTERED.

York Electrical Co., Ltd. (77,119).—This company was registered on April 22nd, with a capital of £5,000 in £1 shares, to adopt an agreement with W. Wainhouse and W. McKay, to acquire the business of an electrical engineer now carried on by the said W. Wainhouse, at Century Buildings, St. Sampson's Square, York, as the "York Electrical Co., Ltd.," and to carry on the business of electricians, electrical, mechanical, sanitary and general engineers, electric wire and cable manufacturers, suppliers of electricity for light, heat, motive power, or otherwise, &c. The first subscribers (each with one share) are:—W. Wainhouse, Century Buildings, St. Sampson's Square, York, electrical engineer; W. McKay, Clifford Chambers, York, gentleman: E. Peacock, 8, George Street, York, clerk: T. Hart, 42, Queen Street, Scarborough, solicitor; W. E. McKay, Clifford Chambers, York, traveller; Mrs. A. S. Jesper, The Hollies, Acomb, York; and Mrs. E. E. Wainhouse, Century Buildings, St. Sampson's Square, York. No initial public issue. The number of directors is not to be less than two nor more than five; the first are W. McKay (chairman), W. E. McKay and W. Wainhouse (managing director); qualification, £50; remuneration of ordinary directors £50 per annum, divisible; managing director £212 per annum. Registered office, Century Buildings, St. Sampson's Square, York.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Electric Lighting and Traction Co. of Australia, Ltd. (63 334).—An acknowledgment of indebtedness under seal, dated March 31st, 1903, to secure £75,000 debenture stock (making with £75,000 already issued a total of £150,000, and being supplemental to a trust deed dated September 26th, 1901), and a deed dated March 31st, 1903, modifying the terms of such trust deed, has been registered. Trustees, Electric and General Investment Co., Ltd., 1—2, Great Winchester Street, E.C.

Barnsley and District Electric Traction Co., Ltd. (72,962).—A trust deed dated April 8th, 1903, to secure £20,000 debenture stock created by resolution of even date has been registered. Property charged, the company's undertaking and assets, present and future (as a floating security). Trustees, Electric and General Investment Co., Ltd., 1—2, Great Winchester Street E.C.

Rosling & Fynn, Ltd., Electrical Engineers, Bradford (66,319).—A memorandum of satisfaction in full of a debenture dated May 1st, 1902, securing £1,330, has been filed.

A. Reyrolle & Co., Ltd., Electrical Engineers, Hebburn-on-Tyne (70,210).—A first mortgage debenture, dated March 31st, 1903, to secure £5,000, charged on the company's undertaking and property, present and future, including uncalled capital, has been registered. Holders: Lloyd's Bank, Ltd., Newcastle-on-Tyne. A memorandum of satisfaction in full of a debenture dated October 8th, 1902, securing £2,000, has also been filed.

ELECTRICITY SUPPLY AND TRAMWAY ACCOUNTS.

Farnworth U.D.C. Electric Light and Tramways Department.

Of the numerous townships scattered over the southern area of the County Palatine, which have taken upon themselves the burdens and advantages of electric light and tramways, few can boast of the results achieved by Farnworth in its first complete year. The Council obtained its prov. order in 1898, and commenced the business of supply in August, 1901.

For the 12 months ending March 25th, 1903, the department sold 445,912 units. Private lighting at 5d. (flat rate), and at 7d. and 3d. (on the maximum demand system) per unit, took 40,719 units. Power at 2½d. and 1½d. per unit took 74,596 units. Public lighting took 39,262 units, and the tramways department absorbed 291,335 at 1d. per unit.

A good feature of the supply is the large percentage of power and traction units, although in the case of the latter, in meeting the wishes of the tramways department and reducing the price from 1½d. to 1d. per unit, the department is cutting things rather fine.

The load factors are 11·8 for lighting and 16·6 for traction. The works costs at 1·15d. per unit are exceptionally low for the output—a feature for which the department may thank its proximity to colliery districts and its considerable power load. Mr. J. D. Pember is the borough electrical engineer and tramways manager.

LIGHTING DEPARTMENT for 12 months ending March 31st, 1903.

General Statement.

Total capital expended	£33,115
Number of units sold	445,912
Equivalent number of 8-c.p. lamps	12,044
Number of public lamps	45
Maximum load in kw. { Lighting	150
Maximum load in kw. { Traction	200
Revenue Account—	
Gross revenue	£3,329
„ expenditure	2,137
„ profit	1,092
Average price obtained per unit	1·65d.

Revenue Statement.

	Per unit.	Gross.
Sale of energy for private and public lighting and tramways	1·63d.	£3,019
Motor and meter rentals	·12d.	198
Sundries	·00d.	12
Total	1·74d.	£3,229

Working Expenses.

	Per unit.	Gross.
Coal	·46d.	£848
Oil, waste, water and engine room stores	·10d.	183
Wages incurred in generating	·18d.	340
Repairs and maintenance, wages and material	·04d.	68
Distribution, wages and material	·08d.	146
Street lamps „ „	·07d.	130
Works and distribution costs	·93d.	£1,724
Rent, rates and taxes	·08d.	149
Management, stationery, general establishment charges, &c.	·14d.	263
Total works costs	1·15d.	£2,136

Profit Statement.

Interest and sinking fund	£1,030
Balance carried forward	62
Gross profit	£1,092

TRAMWAYS DEPARTMENT for 12 months ending March 31st, 1903.

Length of route	4½ miles
Car-miles run	223,518
Electrical energy used for cars (units)	284,523
Units per car-mile	1·27
Passengers carried per annum	1,063,390
Capital expenditure to date	£42,650
Traffic receipts	£7,016
Working expenses	£5,282
Gross profit	£1,734
Income per car-mile	7·58d.
Working expenses per car-mile	5·69d.
Rental of lines per car-mile	1·41d.
Interest and sinking fund per car-mile	2·55d.
Total expenses per car-mile	9·65d.
Balance per car-mile	−2·47d.
Average fare per passenger	1·01d.
Price of energy per unit	1d.
Revenue per mile of route	£390
Expenditure per mile of route	£497

ANALYSIS OF WORKING EXPENSES.

	Gross.	Car-mile.
Electrical energy (for cars and sheds)	£1,214	1·32d.
Traffic wages, uniforms, tickets, &c., less advertising receipts	2,150	2·92d.
Car cleaning, wages, sand, salt, grease, &c.	717	·77d.
Repairs and Maintenance—		
Permanent way ·03d. per car-mile		
Overhead equipment ·14d. " "		
Rolling-stock ·55d. " "	672	·72d.
Management, legal expenses, insurance, and general establishment	368	·40d.
Rent, rates and taxes	161	·17d.
Total working expenses	£5,282	5·70d.

The working expenses, at 5·70d. per car-mile, are very creditable to such a small undertaking, but this figure is swelled by interest and sinking fund, 2·55d., and rental of track, 1·41d., to the somewhat high figure of 9·65d. per car-mile total expenses.

As the income per car-mile is only 7·58d., it will be seen that a working loss of 2d. per mile results.

The financial results may be summed up by saying that the gross profit of £1,734 had to be supplemented by a sum of £1,931 from external sources, in order to meet the interest and sinking fund, £2,365, and rent of Kearsley track, £1,300. As the undertaking was of only some 13 months' growth, the results are better than might have been anticipated.

Cambridge Electric Supply Co., Ltd.

THE last financial year of the Cambridge Co. was of a kind which they will wish to repeat. The rapid increase in the company's business has suggested the building of a new generating station and an increase in the area of supply, for which the directors intend to obtain Parliamentary powers. The number of units supplied has increased by nearly 40,000—the gross profit shows a satisfactory increase contributed to by increased revenue per unit and decreased works cost compared with the previous year. Considering the situation of the undertaking and comparatively small load factor, the works costs are as good as can be expected. The supply includes—besides private consumers, only one public lamp which, curiously enough, has consumed 1,535 units in both 1901 and 1902.

The charges are—private lighting, 7d. per unit, power and heat, 3½d.; and public lighting (about) 3½d. per unit. Mr. H. B. Harvey is the manager and engineer.

The progress of the undertaking in recent years will be gathered from the following table:—

Year ending.	8-c.p. lamps connected.	No. of units sold.	Average revenue per unit sold.	Dividend.
1898	25,080	260,307	6·25	7 per cent.
1899	28,123	298,392	6·22	7 "
1900	30,986	357,435	5·93	7 "
1901	34,723	382,224	5·90	7 "
1902	38,556	419,005	6·05	7 "

GENERAL STATEMENT.

For year ending December 31st—	1901.	1902.	Inc.
Total capital expended	£72,782	£78,167	£5,385
Number of units sold	382,224	419,005	36,781
Maximum load in kilowatts	508	524	16
Equivalent 8-c.p. lamps connected	34,723	38,556	3,833
Number of public arcs	1	1	—
Revenue Account:—			
Gross revenue	£9,883	£11,099	£1,216
" expenditure	£4,114	£4,186	£72
" profit	£5,669	£6,913	£1,244
Average revenue per unit sold	5·90d.	6·05d.	·15d

REVENUE STATEMENT.

For year ending December 31st, 1902—	Gross.	Per unit.
By sale of energy	£10,585	6·05d.
Meter rents	386	·22d.
Fees, discounts, royalties, &c.	128	·07d.
Total revenue	£11,099	6·34d.

WORKING EXPENSES.

	Gross.	Per unit.
Coal, including carting, &c.	£1,152	·67d.
Oil, waste, water and engine-room stores	251	·14d.
Salaries and wages incurred in generation and distribution	980	·56d.
Repairs and maintenance of plant, cables, &c.	461	·26d.
Total works and distribution costs	£2,844	1·63d.
Rent, rates and taxes	504	·29d.
Management expenses, directors' and auditors' fees, &c.	554	·31d.
General establishment charges, printing, stationery, law, insurance, &c.	284	·16d.
Total costs	£4,186	2·39d.

PROFIT STATEMENT.

Interest on temporary overdraft	£121
Dividends on ordinary stocks and shares	5,275
To depreciation on works, plant, &c.	1,000
By balances brought forward from last year	— 171
Balance carried forward	688
Gross profit	£6,913

To the profit on the year's working—£6,913—is added a sum of £171, balances from a previous year—making a total of £7,084—out of which interest and dividends are provided—a sum of £1,000—applied to depreciation, making a total of £4,250, provided for that purpose in ten years—a small percentage on the capital employed—and a balance of £688 is carried forward.

CITY NOTES.

The General International Wireless Telegraph and Telephone Co., Ltd.

BEFORE the passing of the Companies Act, 1900, it was usual to publish a prospectus for the purpose of inviting subscriptions to the capital of the company. A prospectus usually outlines the prospects of the new company, but it is so generally recognised as an inducement to subscribe, that we do not know what to call a lengthy advertisement which outlines the prospects of "The General International Wireless Telegraph and Telephone Co., Ltd.," which "advertisement is for public information and for commercial purposes only, and is not intended as an invitation to subscribe for or to purchase shares, and no application for shares can be received." The capital of the company is £175,000, and we regret to note that only £55,000 forms working capital. The composition and allocation of the other £120,000 might have been of interest as an item of "public information." The company owns the patent rights of the Orling-Armstrong system. The scope of these patent rights or applications is reported on by "Mr. E. A. Goddin, the well-known expert, who has made wireless telegraphy and telephony a special study," but the advertisement does not say to whom Mr. E. A. Goddin is well known as an expert on this or any other electrical subject. As an example of prospectus writing, which combines high-sounding phrases with a total absence of definite statement, we think the following paragraph to be without a rival (the italics are ours):—"*It is claimed* that by the Armorl system telephonic or telegraphic communication can now be effected without the use of wire for an *appreciable* distance, and *it is confidently anticipated* that further experience *will demonstrate* that *it will be difficult to set a limit* to the distance over which the system can be made to operate satisfactorily." We note that the *Westminster Gazette*, in quoting from the advertisement, that "the company hope shortly to be able to supply the wireless telephone and telegraph instruments for social and commercial purposes," remarks that "the notification will be read with appreciation as well as interest by shareholders in the Marconi Co., as well as by the promoters of the Lodge-Muirhead system." We have not heard of any "promoters" of the last-mentioned system, but we may remark that, as might be expected from the scientific attainments and high standing of Sir Oliver Lodge and Dr. Muirhead, their system is one which is based on scientific principles understandable by the scientific world. When the same can be said for the Armstrong-Orling system, a better appreciation can be formed of their commercial prospects. Until then, we trust that the public will take due note that applications for shares cannot be received, and will also take the prohibition to apply to transfers from existing holders.

In connection with this we wish to draw the attention of our readers to a book review on page 760 of this issue.

Submarine Cables' Trust.

THE report for the year ended 15th ult., to be submitted at the meeting on the 5th inst., states that revenue for this period amounted to £24,590 and the expenses to £1,213, leaving a balance of £23,377, to which is added the sum of £71 brought forward from the last account, making an available balance of £23,448. After providing £19,527 to meet payment of the coupons, the sum of £3,803 has been transferred to the redemption fund, leaving a balance of £118 to be carried forward. In accordance with the terms of the trust deed, 35 certificates have been redeemed since the last report by purchase in the open market, costing £3,803, as above. The Commercial Cable Co. having offered to its shareholders a proportion of new shares at par, amounting to one-eighth of their existing holdings, the trustees, by a unanimous resolution, agreed to accept the offer on behalf of the trust. The certificate holders will be asked, in accordance with the terms of the trust deed, to confirm such resolution.

City of Birmingham Tramways Co.

The report for 1902 states that revenue account, after providing for the year's interest on debentures (£12,000), dividend on preference shares (£10,000) and other charges, shows a surplus of £31,585, out of which an interim dividend at 5 per cent. per annum on the ordinary shares (amounting to £2,104), has been paid for the six months ended June 30th last, leaving a disposable balance of £29,480. Five per cent. is paid on the preference shares, and 5 per cent. dividend and 5 per cent. bonus on the ordinary shares, and the balance of £21,083 is carried to the reserve fund (increasing that fund to £191,185), to provide for depreciation of assets, redemption of debentures and for general purposes. The number of passengers carried was 47,960,869, an increase of 1,576,578 passengers. Gross earnings at £254,691 show an increase of £18,634, while net earnings at £51,781 record a decrease of £14,419. During the year £19,572 has been expended on renewals of tramways in excess of the amount expended in the preceding year. This expenditure has been charged against revenue and explains the decrease of the net earnings. Debenture redemption fund has been increased during the year by the payment of a further £10,000 to the trustees, and this, together with interest accumulations to date, raises that fund to £31,263. A Bill, approved by special resolution of the shareholders, is being promoted in the present session of Parliament, in the joint names of this and other companies and the surrounding local authorities outside Birmingham, for securing continuity of services over the lines inside the city from the suburban districts, for the construction of additional tramways in the districts of Yardley and Solihull and for other purposes. An agreement has been made with the Yardley Rural District Council, providing for the adoption of electric traction, and the extension on terms of the company's tenure until 1933. An agreement has also been concluded with the King's Norton and Northfield Urban District Council, under which the company obtains a lease until 1911 of certain tramways authorised by the Council's Bill of 1901, which tramways, three miles in length, pass through Stirchley and Cotteridge to King's Norton. These tramways can be operated in conjunction with the company's Bristol Road service, and from the same generating station. Negotiations are pending with the Corporation of Birmingham in relation to the tramways at present leased, with a view to conversion to electric traction and extension of the leases.

New Zealand Electrical Syndicate.

The directors' report for the year 1902 shows a balance at credit of profit and loss account of £4,595 (including £219 brought forward), after paying interest on the debentures and dividends on the preference shares of the company, writing down the stock in New Zealand by the sum of £477, and debiting the sum of £2,129 for repairs and maintenance. The directors now propose to write off the whole of the suspense account, amounting to £1,500, the whole of the furniture account standing in the books in New Zealand amounting to £173, and the whole of the expenses incurred in amending the Wellington Electric Lighting Act, amounting to £263, and to pay a dividend of 10 per cent., less income-tax, on the ordinary shares of the company, which together will absorb £3,411, leaving a balance of £1,183 to be carried forward. During the year £9,721 has been spent upon extra plant, and additional plant of considerable value has been ordered to provide for the growing business of the company. The directors (having exercised the power of the company to pay off the balance of the first mortgage debentures amounting to £24,000, and in view of the notice which will shortly be given to the holders of these debentures that they will be paid on November 1st next), have not dealt in the accounts with the sum of £1,500, which otherwise would have been set aside for the redemption of these debentures, under Clause 10 of the conditions attached thereto. Notice will also shortly be given to pay off the second and third mortgage debentures, amounting, with premiums to be paid thereon, to the sum of £40,950. In lieu of the above three issues of debentures, it is proposed to create and issue £75,000 5 per cent. first debenture bonds of the company. It is further proposed to increase the capital of the company, a notice calling an extraordinary general meeting of the company for this purpose being enclosed herewith. As intimated in a previous report, steps are being taken to change the name of the company to the "City of Wellington Electric Light and Power Co., Ltd."

Eastern Extension, Australasia & China Telegraph Co.

The report for the half-year ended December 31st, 1902, states that the gross receipts amounted to £267,553, against £324,209. The working expenses, including £24,672 for maintenance of cables, absorb £121,870, against £120,294 for the corresponding period of 1901, leaving a balance of £145,684. From this is deducted £7,565 for income-tax, £9,465 for interest on debenture stock and expenses in connection therewith, leaving as the net profit for the half-year £128,654. After adding £73,526 brought forward, there is an available balance of £202,180. One quarterly dividend of 1¼ per cent. has been paid for the half-year, and it is now proposed to distribute another of like amount on May 7th, making with the interim dividends paid for the first half-year a total dividend of 5 per cent. It is also proposed to pay a bonus of 4s. per share, or 2 per cent., making a total distribution of 7 per cent. for the year 1902. The sum of £30,000 has been transferred to the general reserve fund, and the balance of £37,180 carried forward.

The Okonite Co.

"Though the Okonite Co., as promoted by Woodhouse & Rawson, had such an unfortunate career in this country and was obliged to close down the works at Manchester, the present reconstructed undertaking, as mainly carried on in the United States, appears to be achieving considerable success. The past year was the second under the reorganisation, and the accounts of the annual meeting which have just come over show that the profits were sufficient, after allowing for all charges, to pay 6 per cent. on the ordinary shares and to carry forward £18,500, making, with the balance brought forward from 1901, when no dividend was distributed, a total surplus of £27,900. In addition, during the two years £5,900 has been placed in trust for bond redemption, and notes outstanding for borrowed money to the extent of £17,200 have been extinguished. The only obligation for notes now is all against merchandise. The chairman at the meeting in America the other day stated that business had been better than ever so far this year, and that the company has been compelled by expanding orders to add to its buildings and plant. This is the sort of story the old shareholders would have liked to have heard 10 years ago."

So says the *Financial Times* of April 23rd. Those who remember, with us, the very stormy meetings of the early nineties when the late Mr. Samuel Pope, K.C., had to exercise all the tact and diplomacy of which he was possessed to reduce the heat to a safe temperature, will fully appreciate the point of the closing sentence of our contemporary's comment. Okonite, Elmore, and Woodhouse and Rawson shareholders' meetings were about the stormiest electrical events that have been held in London. At any rate, there has been nothing like them since, unless, perhaps, it be Automatic Telephones. It is very satisfactory to find one of the concerns rising Phœnix-like from the ashes, even though it be on the other side of the briny.

Brisbane Electric Tramways Investment Co.

The report for the year ended December 31st, states that the net amount in dividends received on the shares held by this company after deducting tax was £40,327, making with sundry receipts and the amount brought forward, a total of £47,914. After deducting general charges in London and expenditure in Brisbane, including the insurance undertaking by this company under its contract with the tramways company, there remains a net balance available of £44,836. Debenture interest has absorbed £18,000, and an interim dividend has been paid on the preference shares amounting to £9,375. There thus remains a sum of £17,461, and the directors recommend a balance dividend of 2s. 6d. per share on the preference shares, making up the full dividend at the rate of 5 per cent. per annum, and the carrying forward of £8,086.

The German Atlantic Telegraph Co.

The directors have forwarded us a copy of the company's report for 1902, which forms the second complete year since the establishment of the German cable to New York. The report states that an increase took place in telegraph communication amounting to over 500,000 words as compared with 1901, and this notwithstanding two interruptions in working which occurred for 12 days in February and March. Both the defects arose in the neighbourhood of Start Point, on the English coast, and the weak cable at that spot had now been replaced by a specially strong cable. No fault occurred during the year at the Haaks lightship. An opportunity did not arise in 1902 of renewing about 50 knots of cable on the Dutch coast, as had been contemplated, but the work of substituting a stronger cable was carried out in a short time by the cable-ship *Von Podbielski* in March, 1903. The report proceeds to observe that in order to provide the money for the construction and laying of the second German Atlantic cable, the friendly banking syndicate offered for subscription last July the authorised issue of 4 per cent. obligations amounting to £1,000,000, and the sum was considerably over-subscribed. The construction of the duplicate cable was entrusted to the North German Marine Cable Works, of Nordenham, and at the end of 1902, 970 knots had been completed. The necessary soundings along the proposed route of the new cable were carried out on the *Von Podbielski* between May 14th and July 23rd. It is proposed to lay the first section of the cable in such a manner that the new cable-steamer *Stephan*, after landing the coast cable at Borkum by means of lighters, will lay the cable to the end of the English Channel on one journey, and on a second expedition it will continue the work from there to the Azores, whilst the *Von Podbielski* will lay the coast cable at the Azores. It is intended to begin operations in the middle of May and conclude them by the end of July. The company has opened a cable school at Emden at a cost of £2,250 for site and building, and some of the rooms serve at the same time as a statistical bureau. The equipment of the school is very complete, and comprises all the usual apparatus and instruments used in cable working and laying and in making measurements. The paid-up share capital remains unaltered at £1,050,000, and the issue of bonds to the extent of £1,000,000 comes in the accounts for the first time, although the latter on this occasion only bear interest for six months. After meeting general expenses, the cost of cable repairs, interest charges, transferring £12,396 to the cable redemption and renewal fund and writing off £1,955 for depreciation of cable stocks, apparatus, tools and furniture, the profit and loss account shows a surplus of £74,555, as compared with £60,441 in 1901. It is proposed, at the meeting to be held on May 14th, to recommend the payment of a dividend at the rate of 5 per cent. on the paid up capital, as against 4½ per cent. in the previous year.

Oriental Telephone and Electric Co.

Sir Auckland Colvin presided at the annual meeting of this company, held on Wednesday at Cannon Street Hotel, and in moving the adoption of the report (which was printed in our issue of April 24th), he explained the reason for the net revenue being somewhat less than in 1901, it being chiefly caused by there being no particular emergency call made upon the electrical department. Then, further, their manager of that department was away on furlough, and his *locum tenens* fell ill with typhoid. The possibility of increasing the receipts of the electrical department would depend upon the amount of capital they were able to place behind it. He was pleased to state that the Indian licenses, which might have expired in 1907, or in any case in 1915, had been renewed for a longer period, and on more equitable terms. The period was for 60 years, and the Government would not claim any right to purchase for 20 years from the present date. It was part of the agreement that the company should, within five years, convert to metallic circuits and underground cables wherever practicable. This would necessitate raising considerable funds, and the matter was now receiving the directors' attention. When the shareholders were last year asked to take up the new shares, only 8,000 were applied for, and unless applications were shortly received for the remainder, they would have to call the shareholders together again to consider what was to be done. In addition to the purposes mentioned, money was also needed for the Egyptian Co. for construction of provincial telephone lines. That company was continuing to grow with increasing success.

The report was adopted, the dividend resolution passed, the retiring directors and auditors re-elected, and a vote of thanks closed the meeting.

Metropolitan District Railway Co.

Mr. R. W. Perks, M.P., presided at the meeting of this company held last week. The meeting approved of the Bill promoted by the Great Northern, Piccadilly and Brompton Railway Co., which is to take current from the power house now being erected at Lot's Road, Chelsea. It was stated that the amount already granted was not sufficient to meet the cost of the outlay upon the electrical conversion; the company was, therefore, under its Bill of this session, taking powers to issue a very considerable amount of additional capital for the purpose of covering the large outlay. Subject to the proprietors' approval, the directors had made a bargain with the Underground Co., whereby the latter agreed to take a large block of £600,000 of second preference stock at the price of 65. This would produce £390,000. The Underground Co. had also agreed to take at par the proportionate amount of debenture stock, £200,000, carrying 4 per cent. These various commitments of the Underground Co. would provide £1,199,750. A resolution approving the agreement referred to between the District Co. and the Underground Co. was carried unanimously.

West Coast of America Telegraph Co.

The report for 1902, to be presented at the meeting on the 5th inst., shows gross receipts amounting to £34,294, as against £32,106 in 1901, showing an increase of £2,187. Working expenses, £24,295, as compared with £23,022 for the previous year, an increase of £1,273. After providing £6,000 for the interest on the 4 per cent. debentures and £800 for the interest on the 4 per cent. income bonds there remains a balance of £3,198, to which is added the sum of £372 brought forward from December 31st, 1901, making a total of £3,571. Of this amount, £2,000 has been placed to the general reserve fund and £1,000 to the maintenance ship's reserve fund, leaving a balance of £571 to be carried forward.

St. James's and Pall Mall Electric Light Co.—The amount of electricity sold by the company for the quarter ended Lady Day last is returned at 2,063,412 units, estimated to produce £33,530, as against 1,989,972 units, which produced £33,166 last year.

Eastern Extension, Australasia and China Telegraph Co.—The directors have declared a dividend for the quarter ended December 31st last of 2s. 6d. per share, together with a bonus of 4s. per share, or 2 per cent., making a total distribution of 7 per cent. for 1902.

Stock Exchange Notice.—The Committee has been asked to allow the following to be quoted in the Official List:—Primitiva Gas and Electric Lighting Co. of Buenos Ayres, Ltd.—Further issue of £70,000 4 per cent. first debentures of £100 each, Nos. 4,001 to 4,450 and 5,001 to 5,250.

Telegraph Meetings.—The meetings of the Cuba Submarine Telegraph Co. and the Indo-European Telegraph Co. were held on Wednesday, and the reports adopted. Our account of the proceedings will be published next week.

STOCKS AND SHARES.

Wednesday Evening.

Business in the Stock Exchange has irregularised a good deal during the past week—that is to say, while some departments enjoy unusual activity, others are reduced to speculating in the unpopular hope deferred. The walking match to Brighton on May Day provides a fruitful subject for discussion in those sections which are helplessly idle, but the markets with which we deal do not require much outside interest to keep them busy. A goodly amount of trade continues to fall to the lot of the electrical supply division, and the various traction securities keep well to the front. Telegraph varieties are better on the whole, but here the absence of business is lamented, and it is thought that nothing short of the new Transvaal Loan will stimulate prices, although to the coming of that long-expected issue almost as much mystery still attaches as was, until a few days ago, connected with the Moat Farm.

Rallying a trifle from their sharp fall, Eastern Extension Telegraph shares have got back to 11½ upon the issue of the company's report. A disquieting feature of this document is the continued drop in receipts, and although the future is hopefully anticipated, it is obvious that the British Government Cable must prove a very severe competitor. Eastern Telegraph Ordinary stock can be bought at a trifle under 120 cumulative dividend. In the Anglo-American group a decline of ¼ has left Anglo "A" stock where it stood a fortnight ago, the senior issues being unchanged. Cuba Telegraph Preference are again better, the high yield bringing in purchasers now that reports from the island tell of a gradual return to pacific prosperity. West Coast of America shares are no better, although the company makes a slightly improved showing this year as compared with the previous twelvemonth.

Telephone descriptions are unusually active. National Preferred changes hands in large quantities round about par every day, and the third Preference shares have recovered to 5¼. The Deferred stock at 78 is a good market, but the two older Preferences are both somewhat neglected. United River Plate Telephones have hardened ¼ in sympathy with the boomlet now progressing in the Argentine Railway market. It may be noted that at the present price these shares return a purchaser 6 per cent. on his money, and in view of the favourable aspect with which the British public is growing to regard the Silver Republic, the price may possibly advance by degrees. Oriental Telephone shares have firmed up to a sovereign upon the issue of the report to which reference was directed a week ago.

Much is being made in certain quarters of the rising tendency observable in British Electric Traction shares. Undoubtedly the company is doing a fine business, and the returns of its associated lines, if carefully analysed, indicate that the present takings are some 50 per cent. above those of the comparative period in 1902. It is as well to bear in mind, however, that the capital has been substantially increased of late, and, what is still more to the point, is it not the case that a certain option over the shares at £15 apiece expires in May? In the circumstances it would not be surprising if the buoyancy should be made to last for a little bit longer.

Amongst the fluctuations in the Electricity Supply sections there stands an improvement of 10s. in Kensington and Knightsbridge Ordinary shares, and a single fall is seen in the loss of ¼ on South Londons. Citys are better on the good quarterly report, and Westminster Preference have risen ¼, being in short supply. Business in this department is fairly active, and the good investment demand will make its influence felt upon prices in time. The provincial list is very quiet, Oxfords being 6, Folkestone 6¼, and Hove 9, while Bournemouth Ordinary are 13, the Preference 10½, and the Second Preference 11. Bournemouth Debenture stock stands at 104½, which is a point above that which Bromley (Kent) Electric Debenture commands. Electric Lighting of Australia Preference shares are 4, and the 5 per cent. redeemable Debenture stock 98½.

In the Traction market, Central London Ordinary and Waterloo and City have both risen a point; on the latter stock it is hoped that the directors will be able to maintain the 3½ per cent. dividend declared for the final half of 1902. Both the "Sewer" stocks have spurted, Districts being up to 40¼ and Metropolitan Consolidated to 91. City and South London stock was sold on Tuesday at 92¼, but the bargain was a special one, and the real price is more like 73½—74½. Great Northern, Piccadilly and Brompton Ordinary shares are now dignified with quotation in the Official List, and stand at 8½—*i.e.*, their par value. The latest steam railway grumble against electric tramway enterprise comes from the Board of the Cathcart District Railway Co. At the meeting held in Glasgow the other day a speaker attributed the decrease in the company's revenue to competition by the Corporation's electric tramway service.

London United Tramways Preference remain at 12, but Buenos Ayres and Belgrano Ordinary are better at 2⅞ bid. Anglo-Argentines at 4½ and Brisbane Electric Tramways Ordinary at 3½ have not changed, but the latter company's Preference are harder at 4⅛. In the miscellaneous division Telegraph Constructions show a loss of £2, and British Insulated are 10s. lower. In both instances the market is so narrow that very little is needed to move prices in either direction.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. †	Dividends for the last three years. 1900.	1901.	1902.	Closing Quotations April 22nd.	Closing Quotations April 29th.	Business done week ended April 29th, 1903. Highest	Lowest
67,100	African Direct Telegraph, 4 % Debs.	100	..	..	..	97 —101	97 —101	..	..
25,000	Amazon Telegraph Co.'s shares, Nos. 1 to 25,000	10	..	..	..	2⅛— 3⅛	2⅛— 3⅛	..	..
119,700£	Do. do. 5 % Debs., Nos. 1 to 1,250 Red.	100	..	..	..	70 — 80	70 — 80	..	..
788,840	Anglo-American Telegraph	Stock	3½%	6l8.	6O/6	48 — 51 xd	48 — 51	..	..
3,105,580	Do. do. do. 6 % Pref.	Stock	6 %	6 %	6 %	89 — 91 xd	89 — 91	90⅜	89
3,105,580	Do. do. do. Deferred	Stock	5s. %	2s.	1/-	9 — 9½	9⅜— 9½	..	..
44,000	Chili Telephone, Nos. 1 to 44,000	5	5 %	5 %	..	4⅛— 4½	4⅛— 5	4½	4⅛
18,333,300$	Commercial Cable	$100	8 %	8 %	..	155 —165 xd	155 —165	..	..
1,841,209	Do. do. Sterling 500 year 4 % Deb. Stock Red.	Stock	..	..	..	89 — 92	89 — 92	90⅜	89½
16,000	Cuba Telegraph	10	4½%	4 %	6¾%	7 — 8	7 — 8	7⅞	..
6,000	Do. 10 % Pref.	10	..	..	..	14½ — 15½	15 — 16	..	..
12,931	Direct Spanish Telegraph	5	4 %	4 %	4 %	2⅝— 3⅛	2⅝— 3⅛	..	..
6,000	Do. do. 10 % Cum. Pref.	5	..	..	..	7 — 8	7 — 8	..	..
60,710£	Direct United States Cable	20	3½%	3½%	..	9 — 10 xd	9 — 10	9⅜	9⅛
92,800£	Direct West India Cable, 4½% Reg. Deb., within Nos. 1 to 1,200, Red.	100	..	..	..	99 —102	98 —102	..	..
4,000,000	Eastern Telegraph, Ord. Stock	Stock	7 %	7 %	..	116 —121 xd	116 —121	120	118⅝
1,955,565	Do. 3½ % Pref. Stock	100	..	..	..	83 — 86	83 — 86	85½	83
1,534,645	Do. 4 % Mort. Deb. Stock Red.	Stock	..	..	..	106 —109	106 —109	107⅛	..
800,000	Eastern Extension, Australasia, and China Telegraph	10	7 %	7 %	7 %	10½— 11½	11 — 12	11⅜	11
830,000£	Do. 4 % Deb. Stock	Stock	..	..	..	105 —108	105 —108	..	..
800,000	Eastern & South African Tele., 4% Mt. Db., Nos. 1 to 3,000, red. 1909	100	..	..	..	99 —102	99 —102	102¼	..
200,000£	Do. do. 4 % Reg. Mort. Debs. (Mauritius Sub.) 1 to 8,000	25	..	..	..	101 —104 %	101 —104 %	..	..
180,227	Globe Telegraph and Trust	10	5½%	5½%	..	8½— 9	8⅝— 9	8⅞	8½
180,042	Do. do. 6 % Pref.	10	..	..	..	12 — 13	12 — 13	12⅜	12½
150,000	Great Northern Telegraph, of Copenhagen	10	15 %	15 %	12½%	24 — 26	24 — 26	..	..
66,900£	Halifax and Bermudas Cable, 4½ % 1st Mort. Debs., within Nos. 1 to 1,200, Red.	100	..	..	..	99 —102	99 —102	..	..
17,000	Indo-European Telegraph	25	10 %	10 %	10%	37 — 41	37 — 41	37½	..
100,000£	London Platino-Brasilian Telegraph, 6 % Debs.	100	..	..	..	100 —104	100 —104	..	..
72,680	Montevideo Telephone, Ltd., Ord. Nos. 1 to 72,680	1	2½%	2½%	..	¾— 1	¾— 1	..	..
86,492	Do. do. 5 % Pref., Nos. 1 to 86,492	1	..	..	..	¾— 1	¾— 1	..	..
1,988,333	National Telephone, Pref. Stock	100	5 %	5 %	6 %	99 —101	99 —101	100⅛	99
1,966,667	Do. do. Def. Stock	100	..	..	4½%	77 — 79	77 — 79	78½	77½
15,000	Do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	13 — 14	13 — 14	..	..
15,000	Do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	12 — 13	12 — 13	..	..
250,000	Do. do. 5 % Non-cum. 3rd. Pref., 1 to 250,000	5	5 %	5 %	5 %	5 — 5½	5⅛— 5⅜	5⅛	5⅛
2,000,000£	Do. do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	97 — 99	97 — 99	98⅛	97⅜
600,000	Do. do. 4 % Deb. Stock Red.	100	4 %	4 %	4 %	102 —104	102 —104	..	..
171,504	Oriental Telephone and Elec. Nos. 1 to 171,504, fully paid	1	6 %	6 %	6 %	¾— 1	⅞— 1⅛	..	..
100,000£	Pacific and European Tel., 4 % Guar. Debs., 1 to 1,000	100	..	..	..	97 —100	97 —100	..	..
11,839	Reuter's	8	5 %	5 %	..	6½— 7⅛	6½— 7⅛	..	..
3,303	Submarine Cables Trust	Cert.	..	..	..	102 —112 xd	102 —112	103	..
58,000	United River Plate Telephone	5	7 %	7 %	..	5½— 5⅝	5½— 6	5⅞	..
40,000	Do. do. 5 % Cum. Pref., Nos. 1 to 40,000	5	..	..	..	4⅝— 5⅛	4⅝— 5⅛	..	..
179,947£	Do. do. 5 % Debs.	Stock	..	..	..	105 —108	105 —108	..	..
15,609	West African Telegraph, Shares	10	..	..	..	3 — 4	3 — 4	..	..
80,008	West Coast of America, Nos. 1 to 80,000 and 53,001 to 53,008	2½	..	..	..	0 — ¼	0 — ¼	..	..
150,000£	Do. do. 4% Debs., 1 to 1,500 guar. by Bras. Sub. Tel.	100	..	..	..	96 — 99	96 — 99	..	..
267,980	Western Telegraph, Ltd., Nos. 1 to 267,980	10	7 %	7 %	..	11 — 12	11 — 12	11⅛	11
75,000£	Do. do. 5 % Debs. 2nd series, 1906	100	..	..	..	101 —104	101 —104	..	..
400,000	Do. do. 4 % Deb. Stock Red.	100	..	..	..	96 — 99	96 — 99	98	..
88,321	West India and Panama Telegraph	10	2½%	..	..	⅜— ⅝	⅜— ⅝	..	..
84,563	Do. do. do. 6 % Cum. 1st Pref.	10	..	..	..	6½— 6⅝	6½— 6⅝	6⅝	..
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	..	..	..	3½— 4½	3½— 4	..	..
80,000£	Do. do. do. 5 % Debs., Nos. 1 to 1,800	100	..	..	..	99 —102	99 —102	..	..

ELECTRICAL RAILWAY, MANUFACTURING AND INDUSTRIAL COMPANIES.

20,000	British Aluminium 7 % Cum. Pref.	10	..	..	..	3 — 4	3 — 4	..	..
800,000£	Do. do. 5 % 1st Mort. Deb. Stock Red.	Stock	..	..	..	75 — 80	75 — 80	..	..
100,000	British Electric Traction	10	9 %	9 %	..	13½— 14	13⅝— 14½	14⅛	13⅞
100,000	Do. do. 6 % Cum. Pref.	10	..	..	..	12 — 12½	12 — 12½	12½	13⅛
600,000£	Do. do. 5 % Perpetual Debenture Stock	Stock	..	..	..	123 —125	122 —125	124½	..
100,000	British Insulated and Helsby Cables	5	15 %	10 %	10 %	8 — 8⅛ xd	7⅞— 8	..	..
100,000	Do. do. 6 % Cum. Pref.	5	..	..	..	5⅞— 6⅛	5⅞— 6⅛	6	..
50,000	Do. do. 4½ % 1st Mort. Deb. Red.	100	..	..	..	103 —107	103 —107	..	..
50,000	¶Browett, Lindley & Co., Ord.	£1	8 %	Nil	..	⅛— ¼	⅛— ¼	..	..
50,000	¶ Do. do. 6 % Cum. Pref.	£1	6 %	6 %	..	16s. to 17s.	16s. to 17s.	..	..
105,731	Brush Electrical Engineering, Ord., 1 to 105,731	2	5 %	Nil	Nil	2— 1⅛	2— 1⅛	1	1⅛
150,000	Do. do. Non-cum. 6 % Pref.	2	6 %	3 %	6 %	1⅛— 1⅜	1⅛— 1⅜	1⅛	1⅛
125,000£	Do. do. 4½ % Perp. Deb. Stock	Stock	..	..	..	99 —102	99 —102	..	..
125,000£	Do. do. 4½ % Perp. 2nd Deb. Stock	Stock	..	..	..	89 — 94	89 — 94	..	..
35,000	Callender's Cable Construction shares	5	15 %	20 %	..	13 — 14	13 — 14	13⅛	..
40,000	Do. do. do. 5 % Cum. Pref.	5	..	..	..	5½— 6	5⅝— 6	..	..
90,000£	Do. do. do. 4½ % 1st Mort. Deb. Stock Red.	Stock	..	..	..	108 —112	108 —112	..	..
1,860,014	Central London Railway, Ord. Stock	Stock	..	4 %	4 %	105 —108	106 —109	106⅛	107½
494,993	Do. do. 4 % Pref. Stock	Stock	..	4 %	4 %	103 —106	103 —106	..	..
494,993	Do. do. Def. do.	Stock	..	4 %	4 %	109 —112	109 —112	111	110⅝
1,880,000	City and South London Railway	Stock	1½%	2 %	3½%	73 — 75	73 — 75	73	73½
85,000	Crompton & Co., Nos. 1 to 85,000	8	8 %	7½%	..	2½— 2⅝	2½— 2⅝	..	..
100,000£	Do. 5 % 1st Mort. Reg. Debs., 1 to 900 of £100, and 901 to 11,000 of £50 red.	..	..	..	..	102 —106	102 —106	..	..
99,261	Edison & Swan United Elec. Light, "A" shares, £3 paid, 1 to 99,261	5	2½%	Nil	..	0 — ⅛	0 — ⅛	..	..
17,139	Do. do. "A" shares, 01—017,139	5	2½%	Nil	..	1⅛— 2⅛	1⅛— 2⅛	..	..
344,038£	Do. do. 4 % Deb. Stock Red.	100	..	..	..	73 — 77	73 — 77	..	..
100,000£	Do. do. 5 % 2nd Deb. Stock Prov. Certs. all pd.	100	..	..	..	75 — 80	75 — 80	..	..
112,100	Electric Construction, 1 to 112,100	2	6 %	6 %	..	1⅝— 2	1⅝— 2	..	..
31,890	Do. do. 7 % Cum. Pref., 1 to 31,890	2	..	..	..	2⅝— 3	2⅝— 3	..	..
82,500£	Do. do. 4 % Perp. 1st Mort. Deb. Stock	Stock	..	..	..	100 —103	100 —103	..	..
25,000	General Electric Co. (1900), 5 % Cum. Pref.	10	5 %	5 %	..	10 — 10½	10 — 10½	10⅛	..
300,000	Do. do. 4 % Mort. Deb.	Stock	..	..	..	99 —102	99 —102	..	..
35,000	Henley's (W. T.) Telegraph Works, Ord.	5	20 %	20 %	20 %	15 — 16	15 — 16	15⅜	15⅛
35,000	Do. do. 4½ % Pref.	5	4½%	..	..	5 — 5½	5 — 5½	..	..
48,050	Do. do. 4½ Mort. Deb. Stock	Stock	..	..	..	107 —111	107 —111	..	..
50,000	India-Rubber, Gutta-Percha & Telegraph Works	10	10 %	10 %	..	18½— 19½	18½— 19½	18½	..
800,000£	Do. do. 4 % 1st Mort. Deb.	100	..	..	..	100 —103	100 —103	..	..
87,500	†Liverpool Overhead Railway, Ord.	10	3½%	1½%	1½%	5⅛— 5⅜	5⅛— 5⅜	..	..
10,000	† Do. do. Pref. £10 paid	10	..	..	..	10½— 11	10½— 11	..	..
7,500	Parker (Thomas), Ltd., Ord., Nos. 1 to 7,500	10	..	..	..	14½— 15½	14½— 15½	..	..
87,850	Telegraph Construction and Maintenance	12	17½%	20 %	20 %	36 — 39	34 — 37	36	35
150,000£	Do. do. 4 % Deb. Bds., Nos. 1 to 1,500 Red. 1909	100	..	..	..	101 —104	101 —104	..	..
540,000£	Waterloo & City Railway, Ord. Stock	100	3 %	3 %	3½%	98 —101	99 —102	..	..

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ From Manchester Share List.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Consolidated Telephone Construction and Maintenance, nil to 6d.
ational Electric Free Wiring, ½—¾.

Oldham, Ashton, and Hyde Electric (£10 pd.), Ord., 14—15.
Do. do. Pref (£10 pd.), 9½—10½.

Bank rate of discount 4 per cent. (October 2nd, 1902).

SHARE LIST OF ELECTRICAL COMPANIES (*continued*).—ELECTRICITY SUPPLY COMPANIES.

Present issue.	NAME.	Stock or Share.	Dividends for the last three years. 1900.	1901.	1902.	Closing Quotations April 22nd.	Closing Quotations April 29th.	Business done week ended April 29th, 1903. Highest.	Lowest.
100,000	Blackheath and Greenwich Dist. Electric Light, Ord...	£ 1	..	..	..	⅜ — ⅝	⅜ — ⅝	..	..
100,000	Do. 4½% 1st Deb. Stock, Prov. Certs. ..	100	..	..	..	118 —121	118 —121	..	..
20,000	Brompton & Kensington Electric Light Sup., Ord., 1 to 20,000 ..	5	6 %	8 %	8 %	10¼ — 11	10¼ — 11	..	..
20,000	Do. do. 7 % Cum. Pref. ..	5	..	..	..	10¼ — 10⅜	10¼ — 10⅜	..	..
50,000	Charing Cross and Strand Electricity Supply	5	9 %	10 %	10 %	9 — 9⅛	9 — 9⅛	9⅞	9½
70,000	Do. do. do. 4½% Cum. Pref. ..	5	..	..	..	5¼ — 5⅜	5¼ — 5⅜	..	..
40,000	Do. do. "City Undertaking" 4½% Cum. Pref. ..	5	..	..	..	4⅜ — 5⅛	4⅜ — 5⅛	..	..
250,000	Do. do. 4 % Deb. Stock Red.	100	..	..	..	105 —107	105 —107	..	..
44,486	*Chelsea Electricity Supply, Ord.	5	5½%	4 %	4½%	6 — 6⅛	6 — 6⅛	6⅛	6½
150,000‡	Do. do. % Deb. Stock Red.	Stock	..	..	..	109 —112	109 —112	..	..
78,595	City of London Electric Lighting, Ord. 40,001—110,595 ..	10	0 %	5 %	5 %	10¼ — 11	10⅜ — 11⅛	11	10⅞
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	6 %	..	..	13¾ — 14¼	13¾ — 14¼	..	..
400,000‡	Do. 5 % Deb. Stock, Scrip. (iss. at 115) all paid	..	..	..	..	122 —127	122 —127	..	..
800,000	Do. 4½% 2nd Deb. Stock, Prov. Certs., all paid	100	..	..	..	103 —106	103 —106	104	..
40,000	County of London & Brush Prov. Electric Lighting, Ord. 1—40,000..	10	4 %	4 %	4 %	8 — 9	8 — 9	..	..
20,000	Do. do. do. 6 % Pref., 40,001—60,000..	10	..	..	..	12 — 13	12 — 13	12⅜	..
400,000‡	Do. do. 4½% Deb. Stock, Prov. Certs. (all paid) Red ..	..	..	..	..	110 —113	110 —113	112¼	..
50,000	Edmundson's Electric Corporation, Ord. Shares	5	7 %	7 %	..	6⅞ — 7⅛	6⅞ — 7⅛	7	..
30,000	Do. do. 6 % Cum. Pref.	..	..	..	..	6¼ — 6⅝	6¼ — 6⅝	6⅝	6½
140,000	Do. do. 4½% 1st Mort. Deb. Stock ..	100	..	..	..	107 —110	107 —110	..	..
21,000	Kensington and Knightsbridge Electric, Ord.	5	12 %	10 %	10 %	10¾ — 11¼	10 — 11	..	..
90,000	Do. do. do. 4 % Debenture Stock ..	Stock	..	..	..	100 —103	100 —103	..	..
110,000	London Electric Supply Corporation, Limited, Ord.	3	..	..	..	2½ — 2⅝	2½ — 2⅝	..	..
49,840	Do. do. do. 6 % Pref.	5	..	..	..	5⅝ — 6	5⅝ — 6	5⅞	..
250,000‡	Do. do. do. 4 % 1st Mort. Deb. Stock Red	Stock	..	..	..	100 —103	100 —103	102½	..
100,000	Metropolitan Electric Supply, 1 to 100,000	10	6 %	6½%	7½%	17½ — 18½	17 — 18	17⅝	17½
220,000‡	Do. do. 4½% 1st Mort. Deb. Stock	..	..	..	..	110 —115	110 —115	112½	..
250,000‡	Do. do. 3½% Mort. Deb. Stock Red	Stock	..	..	..	98 —101	98 —101	..	..
10,852	Notting Hill Electric Lighting	10	7 %	6 %	6 %	14 — 15	14 — 15	..	..
40,000	St. James' and Pall Mall Electric Light, Ord.	5	14½%	14½%	14½%	15½ — 16½	15½ — 16½	16	15⅞
20,000	Do. do. do. 7 % Pref. 20,061 to 40,060	5	..	..	..	8½ — 9½	8½ — 9½	..	..
150,000‡	Do. do. do. 3½% Deb. Stock Red ..	100	..	..	..	98 —101	98 —101	..	..
12,000	Smithfield Markets Electric Supply, Ord.	5	..	..	2½%	3 — 3½	3 — 3½	..	..
50,000‡	Do. do. 4% Deb.	100	..	..	..	88 — 93	88 — 93	..	..
65,000	South London Electricity Supply, Ord.	5	..	..	12½%	3¾ — 4	3¾ — 4	..	..
30,000	Urban Electric Supply, Ord.	5	..	..	..	4¾ — 5⅛	4¾ — 5⅛	5⅛	5
30,000	Do. do. 5 % Cum. Pref.	5	..	..	..	4¾ — 5⅛	4¾ — 5⅛	5⅛	5
110,000	Westminster Electric Supply, Ord.	5	10½%	10½%	12 %	12 — 13	12 — 13	12⅜	12⅛
28,141	Do. do. 5 % Cum. Pref.	5	..	..	..	6½ — 7	6½ — 7	..	..

*Subject to Founders Shares. ‡Unless otherwise stated all shares are fully paid.

MARKET QUOTATIONS. Wednesday, April 29th.

CHEMICALS, &c.		Latest Price.	Week's Inc. or Dec.
a Acid, Hydrochloric	per cwt.	5/-	..
a ,, Nitric	per cwt.	22/-	..
a ,, Oxalic	per cwt.	32/-	..
a ,, Sulphuric	per cwt.	5/6	..
a Ammoniac, Sal	per cwt.	42/-	..
a Ammonia, Muriate (crystal) ..	per ton	£33 10	..
a ,, ,, ...	per ton	£30	..
a Bleaching powder	per ton	£4 10	..
a Bisulphide of Carbon ..	per ton	£15	..
a Borax	per ton	£13	..
a Benzole (90 %)	per gal.	7/-	..
a ,, (50/90 %)	per gal.	5/6	..
a Copper Sulphate	per ton	£21 15	£2 dec.
a Lead, Nitrate	per ton	£24	..
a ,, White Sugar	per ton	£31	..
a ,, Peroxide	per ton	£27 10	..
a Methylated Spirit	per gal.	2/6	..
a Naphtha, Solvent (90% at 160° C).	per gal.	5/6	..
a Potash, Bichromate, in casks ..	per lb.	3d.	..
a ,, Caustic (75/80%)..	per ton	£24	..
a ,, Bisulphate	per ton	£35	..
a Shellac	per cwt.	121/-	2s. inc.
a Sulphate of Magnesia	per ton	£4 10	..
a Sulphur, Sublimed Flowers ..	per ton	£6 5	..
a ,, Recovered	per ton	£5 10	..
a ,, Lump	per ton	£5	..
a Soda, Caustic (white 70 %) ..	per ton	£10 15	..
a ,, Crystals	per ton	£3	..
a ,, Bichromate, casks.. ..	per lb.	2¼d.	..

METALS, &c.			
b Aluminium Ingots, in ton lots ..	per ton	£130	..
b ,, Wire, in ton lots ..	per ton	£168	..
b ,, Sheet, in ton lots ..	per ton	£166	..
p Babbitt's metal ingots	per ton	£43 to £145	..
c Brass (rolled metal 9" to 19") basis	per lb.	7¼d.	..
c ,, Tube (brazed)	per lb.	9¼d.	..
c ,, ,, (solid drawn).. ..	per lb.	7¾d.	⅛d. dec.
c ,, Wire, basis..	per lb.	7¼d.	..
c Copper Tubes (brazed) ..	per lb.	9¼d.	⅛d. dec.
c ,, ,, (solid drawn) ..	per lb.	9⅜d.	⅛d. dec.
g Copper Bars (best selected) ..	per ton	£75	£3 inc.

METALS, &c. (*continued*).		Latest Price.	Week's Inc. or Dec.
g Copper Sheet	per ton	£75	£3 dec.
g ,, Rod	per ton	£75	£3 dec.
e ,, (Electrolytic) Bars ..	per ton	£72	..
e ,, ,, Sheets ..	per ton	£83	..
e ,, ,, Rod ..	per ton	£73 10	..
e ,, ,, H.C. Wire	per lb.	8¾d.	..
f Ebonite Rod	per lb.	8/-	..
f ,, Sheet	per lb.	5/-	..
n German Silver Wire	per lb.	1/6	..
h Gutta-percha fine	per lb.	8/-	..
h India-rubber, Para fine ..	per lb.	8/10 to 8/11½	..
i Iron, Charcoal Sheets	per ton	£18	..
i ,, Pig (Cleveland warrants)	per ton	46/7½	2s. 1½d. dec.
i ,, Forgings, according to size	per ton	From £11	..
i ,, Scrap, heavy	per ton	47/6 to 50/-	..
i ,, Wire, galvanised No. 8 ..	per ton	£9 15	..
g Lead, English Ingot	per ton	£12 5	7/6 dec.
g ,, ,, Sheet	per ton	£14 10	..
m Manganin Wire No. 28	per lb.	8/-	..
g Mercury	per bot.	£8 12 6	..
d Mica (in original cases) small ..	per lb.	3d. to 1s.	inc.
d ,, ,, ,, medium	per lb.	2s. to 3/3	inc.
d ,, ,, ,, large ..	per lb.	3/6 to 7/8	inc.
p Phosphor Bronze, plain castings	per lb.	1/- to 1/2½	..
p ,, rolled bars & rods	per lb.	1/1 to 1/4	..
p ,, ,, strip & sheet	per lb.	From 1/2	..
o Platinum	per oz.	£4	..
p Silicium Bronze Wire	per lb.	10d. to 1/-	..
i Stee., Magnet, acc'd'g to desc'p'n	per ton	£58	..
i ,, ,, in bars		£15 to £40	..
g Tin, Block	per ton	£138 10 to £139 10	30s. inc.
g ,, Foil	per lb.	1/6½	..
n ,, Wire, Nos. 1 to 16 ..	per lb.	1/9	¼d. dec.
p White Anti-friction Metals— "White Ant" brand ..	per ton	£42 to £65	..
j Yarns, 2/10s Grey Cotton, on sp'ls	per lb.	7¼d.	..
j ,, 6 lea. Flax	per lb.	5¾d.	..
j ,, 3 ply 10 lbs. Russian ..	per lb.	4¼d.	..
j ,, 10 lbs. Russian, single ..	per lb.	4¼d.	..
j ,, 180 lbs. Jute rove	per ton	£11	..
k Zinc, Sh't (Vieille Montagne bnd.)	per ton	£26 15	..

Quotations supplied by:—*a* Messrs. G. Boor & Co.; *b* The British Aluminium Co., Ltd.; *c* Messrs. Thos. Bolton & Sons., Ltd.; *d* Messrs. F. Wiggins & Sons.; *e* Messrs. Frederick Smith & Co.; *f* India-Rubber, G.P. and Teleg. Works Co., Ltd.; *g* Messrs. James & Shakespeare; *h* Messrs. Edward Till & Co.; *i* Messrs. Bolling and Lowe; *j* Messrs. W. H. Hindley & Co.; *k* Messrs. Morris Ashby, Ltd.; *m* Messrs. W. T. Glover & Co., Ltd.; *n* Messrs. P. Ormiston & Sons; *o* Messrs. Johnson, Matthey & Co., Ltd.; *p* The Phosphor Bronze Co., Ltd.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Locality.	Week ending	Receipts for the week. £	*	Total to date. £	*	Miles open.	*
Aberdeen	Apr. 25	929	+231	44,972	+11,678	—	—
Birmingham	,, 25	4,798	— 68	84,201	+ 4,679	—	—
Blackburn	,, 24	406	+ 96	3,848	+ 524	12½	+1½
Blackpool and Fleetwood	,, 25	296	+ 8	4,311	+ 421	7½	—
Bolton	,, 26	1,751	+215	7,243	+ 1,519	—	—
Bradford	,, 26	3,954	+514	15,944	+ 1,198	39	+2
Bristol	,, 24	4,476	+235	—	—	28	—
Burnley	,, 25	732	+ 64	—	—	—	—
British Elec. Trac. Co.:—							
Barnsley District ..	,, 17	251	—	2,570	—	—	—
Devonport	,, 17	468	+ 54	6,100	+ 160	5	—
Dudley—Stourbridge..	,, 17	1,169	+495	11,203	+ 1,149	18½	—
Gateshead	,, 17	924	+258	12,579	+ 2,787	10½	+ ½
Gravesend—Northfleet	,, 17	272	—	2,853	—	3½	—
Greenock—Pt. Glasgow	,, 17	553	+ 2	6,550	+ 482	7½	—
Hartlepool	,, 17	246	+ 51	3,460	+ 513	6½	+2
Kidderminster	,, 17	186	+ 76	1,617	+ 100	4½	—
Merthyr	,, 17	284	+184	2,805	— 148	3	—
Middleton	,, 17	466	+189	3,902	+ 98	8½	—
Oldham—Ashton ..	,, 17	691	+206	8,188	+ 967	8	—
Peterborough	,, 17	205	—	1,695	—	—	—
Poole	,, 17	415	+159	3,801	+ 687	8½	—
Potteries	,, 17	1,625	+179	23,110	+ 1,989	28½	—
Rothesay..	,, 17	201	+155	832	+ 830	—	—
Sheerness	,, 18	292	—	292	—	—	—
Southport	,, 17	435	+209	3,655	+ 1,262	8½	—

Locality.	Week ending	Receipts for the week. £	*	Total to date. £	*	Miles open.	*
B.E.T. Co. (*continued*)—							
South Staffordshire ..	Apr. 17	1,117	+381	11,255	+ 36	21½	—
Swansea	,, 17	591	+182	6,927	+ 579	5½	—
Taunton	,, 17	78	+ 22	803	— 42	1½	+1½
Tynemouth	,, 17	379	+174	3,197	+ 456	3½	—
Weston-super-Mare..	,, 15	142	—	526	—	2½	+2½
Wolverhampton Dist.	,, 17	562	+407	5,502	+ 3,162	10½	+8
Wrexham	,, 17	142	—	373	—	—	—
Yorks. Woollen Dist..	,, 17	405	—	1,604	—	6	—
Cardiff	,, 25	1,689	+955	6,587	+ 4,695	—	—
Dover	,, 27	185	— 12	3,036	+ 31	3	—
Dublin	,, 24	4,517	— 9	71,208	+ 3,878	46	—
East Ham	,, 25	428	+160	2,351	+ 822	5	+ ½
Glasgow	,, 25	13,298	+1352	590,786	+26,348	64	+12
Isle of Thanet	,, 25	286	—107	5,254	— 606	—	—
Leeds	,, 25	4,827	+191	23,295	+ 2,417	—	—
Liverpool	,, 18	10,120	+682	150,431	+ 8,187	101	+5
Manchester	,, 18	12,009	—	—	—	110	—
Newcastle	,, 25	2,872	+411	—	—	17	—
Portsmouth	,, 25	1,403	+ 91	—	—	22	—
Sunderland	,, 26	1,019	— 52	4,174	+ 146	12	—
Central London Railway	,, 25	7,078	+216	119,008	+ 6,189	6½	—
City and S. London Ry.	,, 26	2,971	— 22	48,788	+ 2,353	6	+½
Liverpool Overhead Ry.	,, 26	1,631	+223	26,218	+ 2,279	6½	—

* Compared with the corresponding period of 1902.

THE HULT ROTARY STEAM ENGINE.

Engineers who have long since given up the rotary piston engine as hopeless, will experience a shock when they first see the Hult engine, and grasp its construction and working. It is the most extraordinary novelty in steam engines that we have come across. At first sight the cross-section appears to be simply that of the old and well-worn shutter piston, in which a flat shutter slides in and out of a slot cut parallel to the axis of a rotating solid cylinder revolving inside a plain cylinder. These shutter engines have been legion, and have varied through all possible arrangements of the shutter in the piston or in the cylinder or in both. The one item in which they have steadily and uniformly failed has been the enormous development of surface rubbed by the edges of the shutters, and by the ends of the rotating piston and of the shutters also.

The extraordinary feature of the Hult engine is, that whereas it has the shutters and the rotary inner cylinder closed in by the cylinder covers, and has all the appearance of the old surface friction, yet it has none of this fault, except only just so much or so little as is good for it. We shall see soon how this extraordinary result has been secured, but may first remark how in modern times certain possibilities in mechanical construction have rendered practicable many things invented years ago, which at the time proved failures, but are now successful.

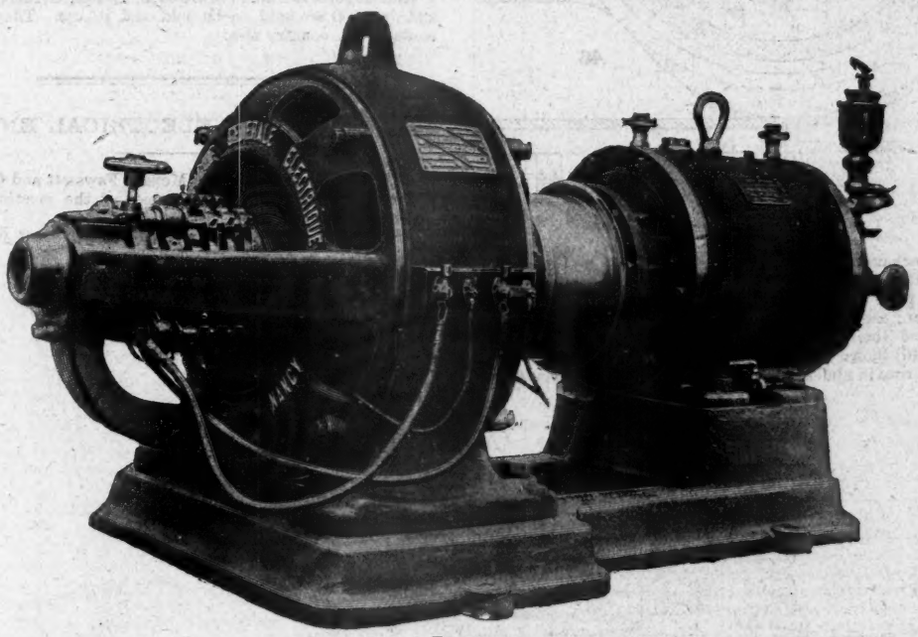


Fig. 1.

This is somewhat the case with the Hult engine. It owes much of its present day possibility to mechanical work, to the possibility of excellent workmanship; but it also embodies a new idea of so truly original a kind that especial credit seems due to the inventor who conceived the idea. The Hult rotary engine might be a fair success without the aid of modern tools, without even the aid of the friction rollers which form a special feature of its construction, but it could not be a success without the original idea now embodied in it; at least, we believe the idea is original. This idea is simply that of making the cylinder revolve upon its axis.

The scheme of the engine is as follows:—A cylinder (1) with closed ends revolves on bearings which form extensions of the cylinder covers. These bearings roll on flat rollers which run on races bored inside the whole containing outer case. Inside the cylinder runs, in rolling contact, another cylinder (7), somewhat smaller in diameter, and therefore having its axis parallel, but not central, with the axis of the outer cylinder. When the inner cylinder revolves it drives round the outer cylinder by contact. The inner cylinder is carried by a hollow shaft (13), supported by sets of smaller rollers which also run on races carried by the outer general casing or frame. In cross-section, therefore, we find two cylinders in contact along a line and with a complete crescent-shaped space between them (fig. 2).

The inner cylinder is slotted for two or three shutters (8A, 8B, 8C) either radial or inclined to the radial line. A light spring keeps the shutters, which slide freely in the slots, in contact with the cylinder, and they are kept very firmly in contact by the centrifugal force when running. The inner piston cylinder and its shutters are a close end fit in the outer or true cylinder, but the old rubbing friction is almost eliminated.

The outer periphery of the piston runs at the same velocity as the inner surface of the cylinder, which it drives round by contact. The shutters project beyond the periphery of the piston, and therefore the outer edge of the shutter in contact with the cylinder travels a little quicker than the cylinder surface, the acceleration commencing as soon as the shutter begins to emerge from its slot after passing the line of contact, continuing up to the opposite end of the diameter and coming back to zero again at the line of contact. A proportionate idea is given by rolling a halfpenny and half a crown together, face to face, against a flat rule, the two coins both touching the rule at the same point. The part of the layer not covered by the smaller coin is like the steam space (1) of the Hult engine. The line of contact is always moving round both cylinders, and the cylinders are never again in contact along the same portion until they have revolved through their least common multiple of revolutions. The line of contact of the cylinders is the only apparent abutment to the steam; if steam tries to leak through at that line, it is rolled out of the surfaces and not drawn between them. Steam is admitted through the piston immediately behind the shutter as soon as this has passed the line of contact. This admission is regulated and cut off by a tube (32) contained in the central shaft which carries the piston. The angular velocity of the piston and cylinder is, of course, inversely proportional to their respective diameters, so that there is a certain small amount of relative movement of their respective end superficies. But the relative movement is a mere fraction of that which would take place where the inner cylinder revolved in a fixed cylinder, and by this ingenious rotating cylinder, the main faults of the old rotary engine are eliminated at a stroke.

At first glance, it does not seem that the engine should run, for here we have two bodies both moving round in the same direction, and actuated by fluid pressure exerted between them. "E pur se muovo," as Galileo said, and to some purpose, and at a high velocity. The smallest Hult engine, 5 B.H.P., runs at 1,500 revolutions, and the largest as yet made, of 200 B.H.P., at 500 revolutions, about 50 per cent. higher speed than the reciprocating engines; the dynamos can thus be made lighter and cheaper. One we saw at Messrs. Simpson's works at Pimlico, of 30 B.H.P., ran up to 760 revolutions per minute without vibration, the engine being simply laid down on an arched floor, and not bolted at all. The only vibration came from the dynamo that was being driven by it. Excepting the rollers and their paths and the shaft, the whole engine is of cast-iron, and most of its parts including cylinder, piston, rollers and roller paths can be turned or bored by the strongest and simplest machine tools, and cut off in lengths from pieces as long as can be machined at once.

The speed of the piston can be 60 to 80 ft. per second, and the power of an engine is increased according to the number of shutters employed.

An adjustment is provided for regulating the pressure along the line of contact. There is but one lubricator for the internal parts. An engine of 200 B.H.P. occupies a space of 6 ft. × 4 ft. × 3 ft., and generally the engines weigh 30 to 35 lbs. per B.H.P., according to pressure and power. The engine seems to be particularly fitted for screw propeller work and dynamo driving.

Reversing is effected by a longitudinal movement of the inner distribution tube, fig. 3. This tube does not rotate with the main shaft, and its ports are so arranged that when the tube is moved by a lever parallel with its axis, the port openings are varied to suit forward or backward running, as the case may be. Here, then, is a high-speed rotative engine, capable of running exceedingly fast, and reversible with a simple movement of a lever, an engine that will not let steam flow to waste if it is brought up standing, and generally a machine which, in its combination of modern roller bearings with the old shutter engine, and the one novel and original idea of the revolving cylinder, is one of the most interesting of the latter-day developments of the steam engine. A reference to the figures will further explain the method of steam distribution.

In fig. 2 of the three-shutter engine, the inlet ports are marked

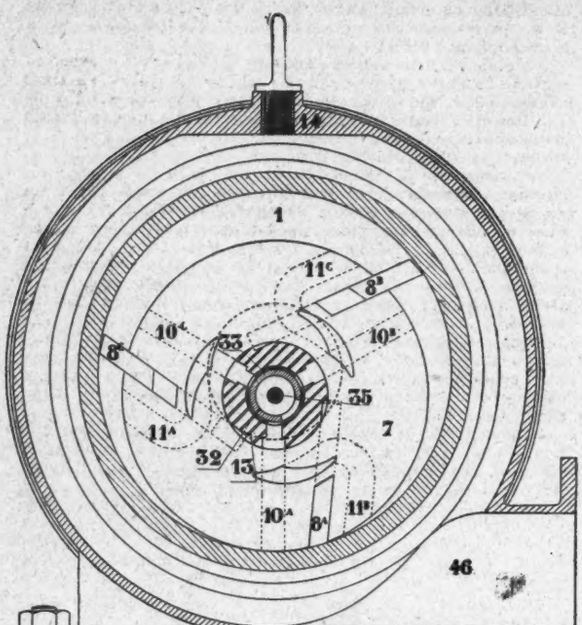


Fig. 2.

10 and the exhaust ports 11, which come out on the end of the piston roller. Owing to the eccentricity of the cylinder and piston, these ports are alternately covered and uncovered by the cylinder cover; the steam exhausts about the cylinder and over the rollers and their paths, and finally escapes from the casing by the pipe (46) shown in the sectional views.

The engine runs in almost perfect balance. It might appear at first as though the radial movement of the shutters in the piston would cause a want of balance. But the piston roller is balanced, *per se*, while the shutters are always in contact with the cylinder and revolve about the same centre, almost but not quite equi-distant, and therefore are balanced. There are, in fact, simply two centres of revolution round which rotate the piston and cylinder respectively, and it is because of their eccentricity that the shutters move in and out of the piston slots.

It is, of course, impossible to indicate the Hult engine. The brake horse-power can be measured in the usual way. A test made in this country of six hours' duration at 115 lbs. pressure showed an average output of 34·818 KW., or 46·67 B.H.P, the B H P being 53 when run non-condensing. The steam consumption was 31 lbs. per B.H P.-hour, which corresponds with, say, 28·5 lbs. per I H P.-hour, and it is claimed that the results of a simple engine are nearly as good as those of the best high-speed compound engines.

Some engineers may argue that the engine ought not to revolve. The fact that it does revolve is easily explained. All gases press normally to the containing surfaces. The steam in the Hult engine therefore presses in a radial direction upon the piston surface and the whole of the lines of pressure must pass through the centre of revolution. There can be no tangential force exerted and so the piston stands neutral and still. Similarly the pressure on the circular inner surface of the cylinder all passes along lines which are radii, and there is no couple tending to move the cylinder. But the shutter obviously is compelled to move, and draws round with it the two neutral bodies.

Many points of advantage are claimed for the engine in addition to those pointed out above. It cannot be injured by priming; it will run at any speed convenient for dynamos without gearing up or down; it is of small weight per H.P., is durable, enclosed and of small volume and cost.

It has, of course, its limits, which arrive when the central valve becomes so large in the larger sizes that it begins to introduce an undesirable friction. But up to such limits the Hult engine appears calculated to do good work.

It will be observed that exhaust must always occur not later than that point where the two shutters from between which steam is being exhausted are equi-distant from the point opposite the line of contact of piston and cylinder. Thus in a two-shutter engine, exhaust begins behind a shutter when this has travelled 270° from the line of contact. With a three-shutter engine it begins when the shutter has passed through 240°, at 225° for a four-shutter engine, or for any number of shutters = N at

$$180° + \frac{180°}{N}.$$

The closure of the exhaust allows sufficient compression to fill the ports to the desired degree.

This engine should be particularly suitable for steam motor-cars.

Hult engines are made in Sweden, Russia, Germany and France, and over 200 are said to be sold and in use. They will soon be made in this country also.

INSTITUTION OF ELECTRICAL ENGINEERS.

The adjourned discussion on Messrs. Fawssett and Constable's and Mr. M. B. Field's papers was resumed at the meeting of the above Institution held on April 23rd.

Prof. Carus-Wilson commented on the great interest of the papers, supplemented by Mr. Duddell's remarks. He questioned whether the stresses on cables, which these papers served to emphasise, were so serious, taking into account the severe tests to which they were subjected. Mr. Field had mentioned the important work done by the I.E.E. of America, and he thought their *Proceedings* might be more widely read over here with advantage. He commented on the similarity of the results obtained by Mr. Field to those of Mr. Steinmetz two years ago and to those of Messrs. Houston and Kennelly. With reference to the rise in voltage, due to resonance, at the receiving end of long transmission lines, the distance would have to be enormous for any appreciable effect, and in a particular case with which he had dealt, of a line 100 miles long, using three No. 0 wires in a triangle and 24 in. apart, the calculated distance for the maximum rise was 1,740 miles. So that for ordinary work this effect was negligible, as was borne out by Mr. Field's paper. [It will be observed, however, that this applies to an *overhead* line.] With high frequencies the effects on the total voltages were fully shown by both Mr. Field and Mr. Duddell. He thought the term resonance was somewhat misapplied, as it was now used for any effect producing high pressure; he also thought that the oscillatory effects were the real thing to contend with in transmission lines, they were frequently met with in practice, and were far greater than resonance. He commented on the similarity of the

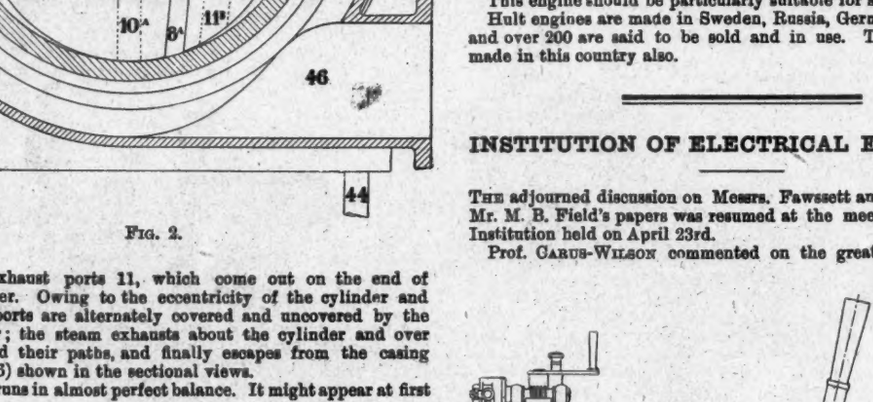


Fig. 3.

results for effects produced by sudden changes in loading, which were obtained by Mr. Field and Mr. Steinmetz. As the result of experiments conducted by the General Electrical Company of America, on breaking long-distance high-pressure circuits—when the break occurred under oil—an oscillatory effect was observed extending over half a dozen waves, the circuit being broken at zero point, so that the rise in volts was nothing—an effect which has been shown on the oscillograph. While there were devices for efficiently breaking circuits, there was no method of preventing the high voltage (sometimes two or three times the normal) consequent on making a circuit.

Mr. G. L. ADDENBROOKE gave the results of experiments in testing cables for dielectric hysteresis for Messrs. Henley's Telegraph Co. He thought of employing the electrostatic system, (which he had previously employed in Paris) as it was very accurate for moderate lengths of cable. Tests of a length of unarmoured lead-covered cable of ·9 microfarad capacity, at 2,000 volts, showed a power factor of 1·34 per cent.; 3,000 volts, 1·67; 4,000 volts, 1·86; 5,700 volts, 1·72, the power factors rising to some extent with the voltage. He proceeded to verify his results by using an air core transformer. As there appeared to be a loss in this apparatus, he tested it and found the loss to vary as the square of the voltage. He considered Mr. Mather's results would be somewhat high owing to the type of apparatus used, but, allowing for this, they confirmed his own. He concluded that with iron sheathed cables the results came out 30 or 40 per cent. higher, and the watt loss increased more than proportionately with the voltage.

Mr. C. P. SPARKES endorsed Mr. Duddell's recommendation as to localising wave records, and commented on the value of the oscillograph in investigating effects. The safest method proposed of switching on high-pressure cables was through a non-inductive water resistance—the modern oil break switch would efficiently disconnect a circuit. Probably the most dangerous conditions met with in practice arose when disconnecting a short-circuited feeder—this would affect the frequency of the machines—and the only safe method was to reduce the voltage.

Mr. CONSTABLE rose to reply to the numerous criticisms on his paper, his remarks being, unfortunately, for the greater part addressed to himself. We, however, gathered that Mr. Duddell's objections to the arrangements of the apparatus described in his paper were unfounded. He pointed out that Mr. Mordey's calorimetric method could not be used after the cables were laid. He had recently conducted some telephonic experiments on a concentric cable, which showed conclusively the existence of an external magnetic field. Referring to Mr. Mordey's remarks on the effects on transformers of switching on and off, he had had, during the past six years at Croydon, no instance of breakdown due to this cause. Referring to meter losses, he considered that the meter which continually required attention was the greatest source of loss.

Mr. M. B. FIELD, replying to the numerous minor criticisms on his use or misuse of terms and mathematical quantities, felt quite justified in using the expression "ohmic resistance" as against, say, "apparent resistance"; he had defined most of the terms used in his paper. While quite aware of Mr. Duddell's photographic arrangement, its prohibitive cost had induced him to construct and use the cheaper arrangement shown in his paper. He did not consider that the sparking on the commutator (direct current) side of the converter would produce any appreciable effect on the alternating system. Speaking of the methods of starting-up and shutting down H.T. circuits, he had noticed at Glasgow that at certain times, a sparking effect occurred from the metal to the woodwork of the switches, these times were found to coincide with the speeds of the generators at which partial resonance occurred. While in America, inquiries had failed to elicit any known effects, due to resonance. He disagreed with Major Cardew's suggestion that the switch had a capacity of its own in series with the capacity of the system; he thought that this switch capacity was so small as to be negligible. He discounted all methods of cable charging except through a non-inductive water resistance. In making cable tests, a moderate voltage applied for a considerable time was better than sudden applications of high voltage, which were productive of partial breakdowns that might remain hidden for some time.

As the discussion threatened to extend to the hours commonly associated with certain other debaters in the neighbourhood of Westminster, Mr. Field decided to communicate the rest of his reply to the *Journal*.

ON ELECTRONS.

By SIR OLIVER LODGE, F.R.S., Vice-President.

(Paper read in London, November 27th, 1902.)

(Concluded from page 714.)

VALIDITY OF OLD VIEWS.

Now that the doctrine of electricity (at least of negative electricity) as located in small charges or charged bodies is definitely accepted, and now that a current can be treated as the locomotion of actual electricity, it may seem as if some doubt were thrown upon the doctrine, which a little time ago was spoken of as a "modern view," that the energy of an electric current resides in the space round a conductor. There is no inconsistency, however. The whole of the fields of an electron are outside itself; it is in its fields that its energy resides, and it is in the space round it that energy is conveyed when it moves; for the ether in that space is subject to the co-existence of an electric and a magnetic field. So, also, its inertia resides in space round it, for it is accounted for by the E.M.F. set up when its magnetic field changes, that is, when its motion is accelerated.

In dealing with the inertia of matter, it is commonly supposed that the inertia resides in the matter itself: whereas electrical inertia is known to reside in the space round the nucleus. Yet we have been emphasising and opposing the view that material inertia and electrical inertia are essentially one and the same.

Is there no inconsistency here?

The appearance of inconsistency vanishes when we come to calculate and realise how extremely local and concentrated the intense part of the field of an electron is. There is a sense in which it can be said that a moving body, for instance, a vortex ring, disturbs the whole atmosphere; but any perceptible disturbance resides very near the ring. So it is with an electron. The magnetic fields falls off inversely as the square of the distance from the moving nucleus, and hence at a distance far less than a millimetre, less even than the size of an atom, it is quite inappreciable. The whole magnetic field on which its inertia depends lies practically very close to the electron itself: it is just its extremely small size that enables this concentration to be possible, and even in a closely packed mercury atom there is practically no encroachment of the field of one electron on its neighbour's. They are all independent, each with its own inertia, almost isolated from the others: for if it were not so, the mass of a body in close chemical combination would not continue constant, but would diminish. Whether it does diminish in the least degree is a question perhaps worthy of attack.*

The momentum of a moving charge at ordinary speeds is simply inversely as the radius of the sphere which holds it, as stated in part I., but the localisation of this momentum, which is the point we are now considering, is given generally in Thomson's "Recent Researches in Electricity and Magnetism," p. 20, and may be realised approximately as follows:—

The momentum depends on the co-existence and product of the electric and magnetic fields. Each field varies inversely as the square of the distance from the moving charge; and their vector product is, as regards direction, perpendicular to the radius vector at any point, and proportional at ordinary speeds to the sine of the angle between the radius vector and the direction of motion, while in magnitude it falls off as the inverse fourth power of the distance. All this can be realised by common sense with very little trouble.

So, then, take a moving electron, and consider the distribution of its momentum in the space round it. Between its surface and a space of a hundred times its diameter, 99 per cent. of its momentum is contained; because we shall have to integrate the factor—

$$\int_a^r \frac{4\pi r^2 dr}{r^4}.$$

So, within the boundary of an atom, which is a hundred-thousand times an electron's diameter, there is practically none of its momentum not included.

And even in one of the comparatively closely packed atoms, *e.g.*, in a platinum or mercury atom, the overlapping of momentum for each constituent is extremely small, since their average space apart is some thousand times the size of each constituent electron.

Consequently the assertions that an electric current is a transfer of electrons, and that the energy of a current travels in the space surrounding the moving electricity, are statements not inconsistent with each other. Nor are the statements inconsistent that the mass of a body resides in its atoms, and that inertia or momentum is a property due to the self-inductive influence of the electro-magnetic field surrounding a moving electric nucleus. So, also, with the way in which a current is propelled. The pace of progression of electrons through a solid may be considerable, see next section, but it is very far below the pace at which a telegraphic signal travels along a wire. They must be propelled by a lateral action, transmitted through the ether with the speed of light appropriate to the surrounding insulator, by some arrangement which "Modern Views" symbolised in the form of cog-wheels; they cannot be impelled by end thrust. The electric current is a more material entity, or has a more nearly material aspect, than was thought probable a little while since; but all that was taught about its mode of propulsion and the diffusion of the propelling force from outside to inside through successive layers, as it were, of the wire, all that was taught about the paths by which the energy travels and arrives at point after point of the wire, there to be dissipated as heat, remains true.

Number of Ions in Conductors.

The immense number of electrons that are necessary to make up the mass of a piece of platinum, or of a lump of matter like the earth, can readily be estimated; so, also, it is easy to imagine that an enormous number must be travelling in order to give customary strengths of current such as can readily pass through a liquid.

Through a gas a limit is soon found to the available number, and accordingly the conductivity of an ionised gas falls off if we call upon it to carry more than a certain current, called the saturation current. See investigations by Townsend and others. But I am not aware of any experimental indication of such a limit in solids or liquids at present. In solids the pace of travel is unknown, though it has been ingeniously surmised, and is thought to be very great; considerations of centrifugal force would make the speed of each electron during an atomic encounter equal to $e/\sqrt{(\kappa m r)}$, or about 10^8 centimetres per second; views based on Maxwell's theorem about equal distribution of energy among the particles of mixed gases suggest 10^7 for the average speed of electrons at ordinary temperatures in a solid where they are free, that is, a hundred

* Cf. Rayleigh, British Association, Belfast, 1902.

kilometres or sixty miles per second; though, since each particle is subject to constant changes of direction, this is by no means the pace of straightforward *progression*. But in liquids they are attached to atoms, and the pace of progression is known both theoretically and experimentally with considerable accuracy, and is comparable to an inch an hour for customary gradients of potential.

The total current is $n e u$; and to give a unit c.g.s. current at so low a speed, we can reckon how many ions there must be,

$$\text{For } e = 10^{-20} \text{ electro-magnetic units;}$$
$$\text{so if we take } u = 10^{-6} \text{ centimetre per second,}$$

then the number of ions engaged in conveying the c.g.s. unit of 10 amperes is $n = 10^{25}$. But, after all, this is nothing very great. It is only about the number of atoms in a cubic centimetre of liquid, and by applying a greater gradient of potential the ions can be made to move faster. By gradually narrowing down the section of a liquid conductor under a given gradient of potential, it might seem possible to get evidence of an approach to a saturation-current density in liquids. The observed accuracy of Ohm's law* under such conditions, however, is against this experimental possibility.

Conclusion.

The subject is very far from exhausted, but I must not attempt to cover more ground. The most exciting part of the whole is the explanation of matter in terms of electricity, the view that electricity is, after all, the fundamental substance, and that what we have been accustomed to regard as an indivisible atom of matter is built up out of it; that all atoms—atoms of all sorts of substances—are built up of the same thing. In fact, the theoretical and proximate achievement of what philosophers have always sought after, viz., a *unification of matter*. And another surprising and suggestive result is that the spaces inside an atom are so enormous compared with the size of the electrical nuclei themselves which compose it; so that an atom is a complicated kind of astronomical system, like Saturn's ring, or perhaps more like a nebula, with no sun, but with a large number of equal bodies possessing inertia and subject to mutual electric attractive and repulsive forces of great magnitude, to replace gravitation. The radiation of a nebula may be due to shocks and collisions somewhat like the X-radiation from some atoms.

The disproportion between the size of an atom and the size of an electron is vastly greater than that between the sun and the earth. If an electron is depicted as a speck $\frac{1}{100}$th of an inch in diameter, like one of the full-stops on this page for instance, the space available for the few hundred or thousand of such constituent dots to disport themselves inside an atom is comparable to a 100-ft. cube; in other words, the atom on the same scale would be represented by a church 160 ft. long, 80 ft. broad, and 40 ft. high, in which therefore the dots would be almost lost. And yet on the electric theory of matter they are all of the atom that there is; they "occupy" its volume in the sense of keeping other things out, as soldiers occupy a country; they are energetic and forceful though not bulky, and in their mutual relations they constitute what we call the atom of matter; they give it its inertia, they enable it to cling on to others which come within short range, and by excess or defect of one or more constituents they exhibit chemical properties and attach themselves with vigour to others in like or rather opposite case.

That such an atom, composed only of sparse dots, can move through the ether without resistance is not surprising. They have links of attachment with each other, but so long as the speed is steady they have no links of attachment with the ether; if they disturb it at all in steady motion it is probably only by the simplest irrotational class of disturbance which permits of no detection by any optional means.† Nor do they tend to drag it about. All known lines of mechanical force reach from atom to atom, they never terminate in ether; except indeed at an advancing wave front. At a wave front is to be found the reaction of a mechanical pressure of radiation whose other component rests on the source. This is an interesting but essentially non-statical case, and it leads away from our subject.

As to the nature of an electron regarded as an ethereal phenomenon, it is too early days to express any opinion. At present it is not clear why positive electrons should cling so tenaciously to a group, while an outstanding negative electron should readily escape and travel free. Nor is the nature of gravitation yet understood. When the electron theory is complete to the second order, or some higher even order, of small quantities, it is hoped that the gravitative property also will fall into line and form part of the theory; at present it is an empirical fact which we observe without understanding; as has been our predicament not only since the days of Newton but for centuries before.

Attention has hitherto been chiefly concentrated on the freely-moving active negative ingredient—the more sluggish positive charges are at first of less interest—but the behaviour of electrons cannot be fully and properly understood without a knowledge of the nature and properties of the positive constituent too.

The positive electron has not, so far as I know, been as yet observed free. Some think it cannot exist in a free state, that it is in fact the rest of the atom of matter from which a negative unit charge has been removed; or, to put it crudely—that "electricity" repels "electricity," and "matter" repels "matter," but that electricity and matter in combination form a neutral substance which is the atom of matter as we know it. Such a statement is an extraordinary and striking return to the views expressed by that great genius, Benjamin Franklin. On any hypothesis those views of his are of exceeding interest, and show once more the kind of prophetic insight which we have had occasion to notice in discoverers before (Appendix H). Undoubtedly we are at the present time nearer to the view of Benjamin Franklin than men have been at any intervening period between his time and ours.

The view that an atom is composed of an equal number of interleaved or inter-revolving positive and negative electrons—to which it will have been observed I myself tentatively and provisionally incline—that view is not Franklin's; nor is it as yet anything but a guess. To make it more, work must be done upon the nature and properties of the positive charge; and the positive electron, if it exists, must be dragged experimentally to light.

Especially must the inner ethereal meaning both of positive and negative charges be explained: whether on the notion of a right and left-handed self-locked intrinsic wrench-strain in a Kelvin gyrostatically-stable ether, at present being elaborated by Larmor,* or on some hitherto unimagined plan. And this will entail a quantity of exploring mathematical work of the highest order.

* Fitzgerald and Trouton, Brit. Assoc. Reports, 1886, 1887, 1888.

† See *Phil. Trans.* 1893, vol. 184, pp. 750—754, also vol. 189, p. 166.

* See "Ether and Matter," p. 326; or *Phil. Trans.* 1894, pp. 810-811, and 1897, pp. 209—212.

SOUTH AFRICAN NOTES.

[From Our Special Correspondent at Johannesburg.]

April 6th, 1903.

Cape Colony.—The Government electrician publishes a warning in the current *Gazette* respecting the use of electric light in bath rooms. Where it is employed, the fittings should be placed in such a position as to be inaccessible from the bath; on no account should "key-holders" be used, porcelain fittings being advised; where feasible, he recommends that the switch should be outside the room altogether.

Claremont, Capetown.—The new works of the Cape Peninsula Electric Light Co., in Claremont, are rapidly approaching completion, and supply for the Capetown suburbs, not already lighted, will shortly be available.

Pietermaritzburg, Natal.—The first consignment of rails for the electric tramways has been despatched from Belgium, and, if arrangements at the Point, Durban, are favourable, is expected in the city in about six weeks.

Lourenço Marques.—The ss. *Harbert, Clan Leslie, Dovedale* and *Comedian*, have recently arrived here all bringing large consignments of material for the electric tramways. Advices have also been received of the despatch from home of boilers, engines and rails for the works. Mr. McIntyre, the South African manager of Henderson's Consolidated, has arrived from Durban to superintend the construction of the works.

Cradock, Cape Colony.—Emulating the example set by the more go-ahead Rand townships, Cradock is now agitating for an installation of electric light. The streets are at present lighted by means of oil lamps which, says the local newspaper, only succeed in making the darkness visible.

Transvaal Telephones.—Telephonic communication has just been established between Johannesburg and Pretoria, and is now thrown open for public use.

THE WÜST SYSTEM OF DRIVING MACHINE TOOLS AND HOISTING MACHINERY.

It is of the greatest importance to adapt machine tools and hoisting machinery to the properties of electric motors, and not to adhere closely to the old forms, but to simplify the mechanical elements as far as possible with regard to the electric motor, which can be reversed and stopped in the most simple manner, can be run with variable speed, and starts easily in any position. These three qualities of the electro-motor, utilised in the right manner, simplify the machines and their handling, and save power. Between the motors connected to the machine and the tool itself, there should be a minimum of mechanism.

Whilst groups of machines can easily be driven from motors with belts, spur-wheels or worm gears, there have been difficulties up to the present with single driving, especially with machine tools which must work with a variety of speeds.

It cannot be asserted that electric single driving is in every case preferable to group driving, yet in the near future it will certainly be demonstrated that machine builders will incline more to single driving than hitherto. For machines which run at high speed, work only occasionally, must be portable, or are frequently at rest, single driving is the most suitable, and much cheaper than mechanical transmission.

With machine tools requiring very variable speeds, such as lathes, boring and milling machines, tapping machines, &c., with direct-current driving the ordinary methods of regulation are no longer sufficient alone, and must be used in conjunction with mechanical speed-regulating devices.

With polyphase motors a speed regulation is obtainable by lowering the voltage in the rotor by inserting resistances. However, this regulation is also combined with a reduction of the output, and the efficiency decreases far more rapidly than the speed. Altering the number of poles is an arrangement which

permits the motor to be run at different speeds inversely proportional to the number of poles; this kind of speed regulation, however, leads to a sacrifice of efficiency, so that such a motor is unfit for constant working.

To make the polyphase motor suitable for the single driving of machine tools with variable speed over a wide range, Messrs. C. Wüst & Co., of Seebach—Zürich, Switzerland, whose interests in

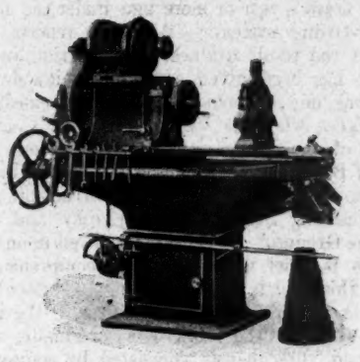


Fig. 1.—Electric Lathe.

this country are in the hands of Messrs. Marryat & Place, London, build special motors with the following qualities:—

1. The speed can be regulated in steps without resistances.
2. At each speed and output they have a constant high efficiency.
3. The output is independent of the speed.
4. They are capable of standing more than 100 per cent. overload for a short time.

The motor represents, so to say, an "electric step pulley," which simplifies the whole driving device and gives the possibility to develop the highest power at the lowest speed, contrary to the electrical arrangements hitherto used, which work with very low efficiency at reduced speed.

Hitherto, it was necessary for avoiding overload at reduced speed to instal a motor with a much higher output than was required at normal speed, so that the motor worked for the most part under uneconomical conditions. This disadvantage disappears with the new motor. The size of the motor should be chosen

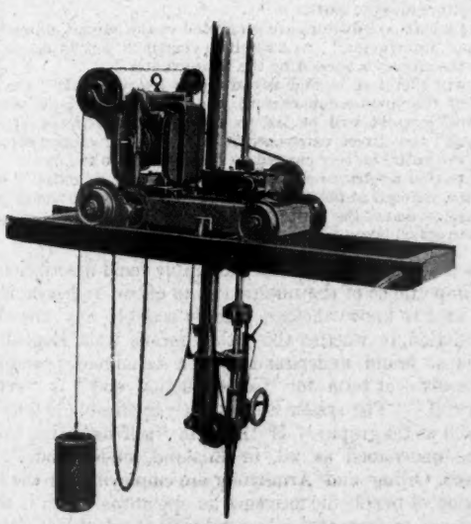


Fig. 2.—Electric Overhead Travelling Drill.

according to the power required. Machines working with regular and short interruptions, such as punching and shearing machines, should be provided with a fly-wheel capable of absorbing the energy during the no-load period, thereby assisting the motor during the working period. With such an arrangement the motor need not supply the full power required during the working period.

The new motors can be adapted, both in output and speed, to all special requirements. In every case the whole control is effected by actuating a single lever of a small controller; only with the larger sizes of the motors are slip rings used to reduce the starting current to a minimum by inserting a resistance in the rotor circuit. Single-phase motors of the new type have the same qualities as the two or three-phase motors, and are capable of being started and reversed with 30 per cent. of full load.

For electrically-driven machines and hoists, worm gearing is one of the principal speed-reducing mechanisms in use, and is one of the best means for dealing with high speed reduction.

It is now, however, rivalled for reductions up to 1: 50 by double reduction gear with double helical wheels, each wheel cut out of the solid on a special machine (patented by Messrs. Wüst). These reduction gears transmit the power in the same direction in which the driving shaft is running, avoiding the end thrust (in the

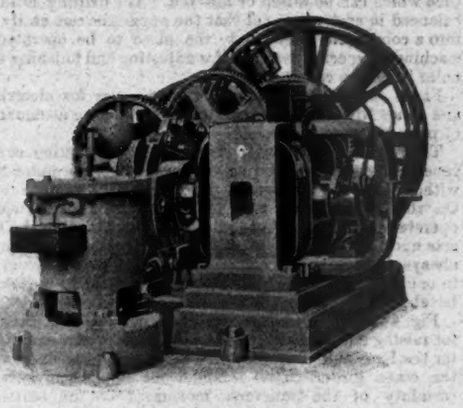


Fig. 3.—Stationary Electric Hoist Gear.

direction of the shaft), which, in worm gears, must be taken up by ball bearings or other energy-consuming devices. They run noiselessly, and are enclosed in an oil bath similar to worm gears, requiring little more space than the latter, are less costly, and have a much higher efficiency than the best worm gears.

As a single reduction gear, these new machine-cut double helical wheels form a substitute for spur gears, to which they are superior as regards durability and smooth running. They are, therefore, especially suitable for traction gears, and for this purpose are already used on the Continent.

For driving with electric motors, headstocks, especially of large lathes, the construction with the new motor is shown in fig. 1. By means of the electric speed regulation already described, and by operating the hand-wheel, seen on the front of the headstock, any

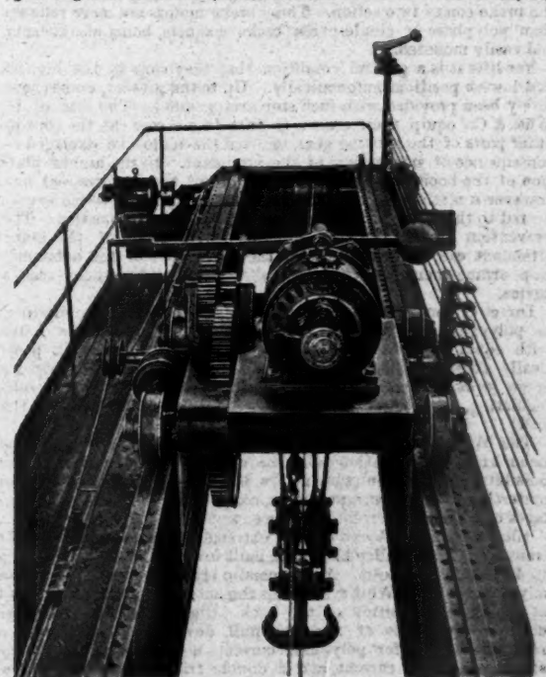


Fig. 4.—Electric Travelling Crane.

required speed can be obtained. The speed can easily be varied at constant and high efficiency. The mechanism is so arranged that with a maximum of overload, the motor continues to run without moving the gearing, so that destruction of the motor is absolutely avoided; thus the principal advantage of belt driving is retained.

This type of headstock can be attached, without difficulty, to any existing lathe, or horizontal boring and milling machine, thus replacing an old and worn headstock.

Electric drilling machines are built in different sizes, with ½, 1, 2, 3, 4 and more H.P. motors. These machines allow of the most varied application, as pillar, radial, universal and wall drilling machines, or horisontal boring and milling machines.

In the new construction the working spindle is directly fitted to the motor, and yet the machine is perfectly adapted for variable speed and variable use with automatic or hand feed. Further, the machine is designed for the quick return of the spindle, whilst the drilling apparatus can be turned in all directions.

An overhead travelling drilling machine for bridge-building shops is illustrated in fig. 2.

A travelling truck is provided with a variable-speed motor (polyphase or direct current). The drilling head itself is attached to a tube which can be raised or lowered. The drilling head is counterbalanced in such a manner that the apparatus can easily be brought into a convenient position to the piece to be operated on. This machine is especially suitable for adjusting and finishing the punched holes in bridge construction.

Fig. 3 represents stationary winding gear for electric passenger and goods lifts, which is controlled without an attendant by means of push buttons.

The working of lifts with single-phase alternating current motors generally requires a winding gear permitting the motor to be started without load and afterwards put into gear by mechanical devices. On the Wüst system mechanical reversing gear, which can be operated automatically or by hand, is connected to the brake which acts upon the worm shaft of the winding gear. From the motor always running in the same direction the movement is transmitted in one or the other direction to the worm gear by means of noiseless bevel gear.

Fig. 4 illustrates an electric crane gear, in which only the motor for raising and lowering the load is fixed on the crab. The motors for the longitudinal and transverse motions are fixed at one end of the crane girder. This arrangement has the advantage that the certainty of the transverse movement of the hoisting gear is secured, even with a strong pull in the longitudinal direction, and this design permits of an extremely simple and reliable construction of the hoisting gear with comparatively small dimensions. The number of transverse wires on the crane is reduced, and the crane hook sweeps the whole clear space of the workshop as far as possible, an advantage gained by scarcely any other arrangement. All bearings of these cranes which are subjected to any considerable thrust, such as bearings of the crane wheels, the wheels of the hoisting gear, the drum axles, &c., are roller bearings, with rollers of silver-steel accurately ground to gauge.

The use of wire ropes instead of chains with fast running electric cranes, as shown, has the advantage, amongst others, that a wire rope never breaks without warning.

The braking of the hoist motors is automatic when working with direct or polyphase currents. In the latter case separate brake motors are used, connected in parallel with the hoist motor. The brake motor opens the bell-crank lever brake by raising a weight. As soon as the current is interrupted (intentionally or otherwise), the brake comes into action. These brake motors are more reliable than polyphase or single-phase brake magnets, being also cheaper and easily mounted.

For lifts it is a general condition that they stop in the highest and lowest positions automatically. Up to the present, cranes have rarely been provided with such stop arrangement. The firm of C. Wüst & Co. equip their cranes so that in no case can the rope or other parts of the hoisting gear, or even the motor, be damaged in consequence of inattention of the attendant. In the highest position of the hook, or in the end positions of the longitudinal and transverse motions, contacts bring the circuit breaker, which is connected to the mains in the cage of the attendant, into action. The prevention of the damage which a single fault of the crane attendant can produce, pays for the extra cost of the automatic stop arrangement, and no crane should be used without such a device.

Direct-current motors with ring armature and series winding, or polyphase motors with different steps of speed, the latter with equal or even higher output at reduced speed with practically constant efficiency, are considered the most suitable for crane work. The series-wound direct-current motor is self-regulating, the speed automatically varying inversely as the load.

The Wüst patent multi-speed polyphase motor admits of the same kind of regulation from the cage of the attendant. The possibility of this regulation makes it fit for crane work, and even preferable to direct-current motors, considering the general advantages of polyphase currents for power transmission.

Electric pulley blocks are an extremely convenient means of transport. These pulley blocks are built in different sizes, from ½ up to 4 tons effective load. An automatic brake secures the latter in any position. The Wüst system has the automatic stop arrangement at the highest position of the hook. Starting and stopping are effected by means of a double-pull device, which controls a reversing switch for polyphase current, a starting and reversing switch for direct current, and a double friction clutch if single-phase current is used.

The load hooks swivel on ball bearings, and the speed reduction gear consists of noiseless running double helical wheels. The screws of the worm gear are hardened and ground; the worm wheels are accurately cut with a worm tapper, and run in an oil bath. Where polyphase current is obtainable, the pulley blocks can be fitted with multi-speed motors, enabling the block to lift light loads with high and heavy loads with low speeds.

The pulley blocks are also built for travelling on a beam.

Stirling Tramways.—The T.C., owing to the failure of the negotiations with various companies for the conversion of the tramways from horse to electric haulage, has authorised the Electricity Committee to take the necessary steps to ascertain the cost of securing a municipal system.

REVIEW.

Wireless Telegraphy and Telephony. Compiled by Dr. Maurice Ernst. London: *Electricity* Office. Price 1s.

For some time past we have sought information as to the *modus operandi* of a system of wireless transmission, of which much was heard a year or more ago under the name of the Armstrong-Orling system. Although reports have been made about the result attained, no indication, so far as we are aware, has been given as to "how it's done." This omission has now, to some extent, been remedied by Dr. Maurice Ernst, who has "compiled" "a Comprehensive Exposition of the Progress made by Wireless Telegraphy from Early Beginnings," which is "Followed by a Popular Description of the Method and the Instruments used in the Orling-Armstrong System of Telegraphy and Telephony through the Ground." We need not dwell upon the exposition, which is brief and not unduly comprehensive. The interest of this "little work" lies in the "popular description" of the Orling-Armstrong system. We are a little uncertain whether the work was originally written in German, and subsequently translated by someone who is unacquainted with the technical terms, or whether it has been written in English from German thought. There are unmistakable signs of German origin, and it is equally obvious that the writer was unable to take advantage of the Kaiser's recent essay on style. Not that we wish to discuss the merits of this work from a literary standpoint. The only consideration we need give to the style or the German origin is in so far as it produces clearness or obscurity in the information conveyed. On p. 20 is an "Explanation of the Orling-Armstrong System: Visible effects," from which we learn that on pressing a key an "interrupter is set into action and thereby the circuit is 'made' and 'broken' in rapid succession through a self-induction coil."

At every "make" the low-tension battery current passes through the self-induction coil and thereby "induces" an *indirect* extra current. At every "break" a *direct* extra current is "induced." Owing to the circuit being broken through the "interrupter" the induced "extra" current is caused to discharge itself by way of conductors into the earth.

These earth conductors are connected to the circuit, on each side of the "interrupter." As a result the earth is put in series every time the circuit is opened by the "interrupter."

It will therefore be understood that at every "make" the resultant of the low-tension current and the inverse high potential "extra" current will be led to the earth. Whereas at every "break" the direct extra current of high electromotive force will with the entire battery current be likewise led to the earth.

In the Orling-Armstrong transmitter the high potential "extra" current, induced at the "break," flows therefore into the ground at the same moment the battery circuit (which is broken through the "interrupter) is completed through the earth."

It is in considering this admirably lucid description that the importance of the question as to origin and style is felt. We need to know whether there is possibly any mistake in translation, or whether the author means what English electricians would understand by the terminology employed. An equivalent term for "self-induction coil" is "retardation coil." The system is apparently applicable to telephony as well as telegraphy. If the term "self-induction coil" is to be understood as we, in England, understand it, then Messrs. Orling and Armstrong are employing for the transmission of telephonic messages an apparatus which is usually employed to *prevent* the transmission of telephonic currents. We think that this cannot be the case. The author probably wishes to describe the very ordinary "shocking coil," which we may properly call a Ruhmkorff coil. The rest of the description is consistent with this interpretation, if it can be called consistent with anything. On this assumption the "high potential discharges" are accounted for, but something is still wanted to explain the utility of the low-tension current. Following the above quotation it is stated that

The importance of this ingenious device cannot be sufficiently dwelt upon. The combination of low-tension currents and high potential discharges which results therefrom, is the prime cause of the remarkable success which Messrs. Orling and Armstrong have achieved.

"The remarkable success which Messrs. Orling and Armstrong have achieved" is perhaps known to Dr. Ernst, but has not yet been apparent to electricians, and these latter will certainly wish for more information about the "combination of low-tension currents and high potential dis-

charges." The virtues of co-operation are considerable, and there is no knowing what might be done by getting high potential discharges and low-tension currents to walk hand in hand, but we think Dr. Ernst will need to write another book to explain to electricians just how the particular blend he describes is obtained. An attempt is made to describe "the invisible effect of this combination of electrical currents on the earth," but we do not feel justified in quoting this in full. The book costs only 1s., and to any electrician in search of amusement the description is worth more than that. There are numerous illustrations, including portraits of the inventors. The final "block" illustrates "Field-Telegraph outfit: For receiving Wireless Telegrams while Marching. System, Orling-Armstrong."

This apparatus consists of a specially-constructed telephone receiver and a wire about 3 yds. long with a piece of metal at the other end. By means of the telephone receiver the "dots" and "dashes" of the Morse code sent from a neighbouring house at a distance of about 500 yds. can be plainly heard. The earth connection is established through the two persons, one of whom "A" holds the receiver while the other, "B," has the piece of metal in his left hand.

We do not know what would be the result if "A" should be less than 3 yds. distant from "B," or if "B" should hold the piece of metal in his right hand instead of the left. Except for the purpose of artistic harmony, we cannot see the utility of "B." If "A" held the telephone in his left hand and laid the "piece of metal" 3 yds. away on the ground, the earth connection ought to be as good as with the assistance of "B." But, seriously, with the infinitesimal difference of potential existing between two men at 3 yds. distance from one another, and making indifferent earth, is it likely that anybody ever deciphered a message not specially arranged on this system?

The very brief reference to other systems of wireless telegraphy is not to be despised; but the apparent seriousness of this part of the work, with the bibliography, is capable of doing incalculable harm to non-technical readers by inferentially conveying an idea of seriousness to the description of the Orling-Armstrong system, which description reminds us of nothing more forcibly than the mock scientific lectures which were popular enough amongst entertainers some years ago, and echoes of which may still be heard occasionally in the patter of an eminent conjurer, who makes a comic mixture of scientific phrases as a preliminary to one of his acts of mystification. Whilst the book gives every indication that the author has been favoured with considerable information on the Orling-Armstrong system, we must guard against the assumption that it is in any way authoritative. The description of the system is not even given as the author's. It is by some anonymous "Electrician."

THE FINANCIAL RESULTS OF A MUNICIPAL EXPERIMENT.

In case any of our readers groan at the recurrence of the Wolverhampton tramway business so often, we beg leave to ask their forbearance for a little while, in that we are not belabouring Wolverhampton so much for its own good as for an example to others. Possibly the example is not required, in which case our labour will be in vain, unless the town chiefly affected elects to turn over a new leaf.

Having been favoured with a copy of the tabulated statement of costs of the nine months' working, from May, 1902, to January, 1903, of the Lorain system, as prepared by Mr. Shawfield, the borough electrical engineer, we desire to criticise it after careful study.

First of all, we would draw attention to the fact that the statement of costs does not include any allowance for depreciation. Mr. Shawfield mentions this in bold type, and thereby proclaims himself one of the select band of municipal engineers who are courageous, or intelligent enough, to hold sound economical opinions on this question of the necessity for providing a depreciation fund in addition to the sinking fund. We hope that his committee will follow his lead, although we fear, from previous utterances, that this is unlikely.

When rumours of the unsuccessful operation of the tramways first flew about, the local papers reported Alderman Craddock, the Acting Chairman of the Tramways Committee, as saying that when the balance-sheet was published the ratepayers would not be displeased with profits earned. Since then the position is unchanged, and we have grave doubts whether Mr. Craddock would express himself as satisfied with a profit of the same description on a year's turnover of boots.

The average cost per car-mile for the nine months is shown as follows:—

Operating costs	...	...	...	=	6·061d.
Maintenance	...	...	...	=	·605d.
„ Lorain equipment			...	=	·534d.
General charges	...	...	...	=	·777d.
Capital charges	...	...	...	=	2·760d.
Total		...	...		10·737d.

The total receipts per car-mile averaged 12·8d., so that the ratio of expenses to receipts is 84 per cent. (always excluding depreciation), and the "profit" is stated at £3,110.

In the first place, we must point out that, although for four months out of the nine the whole of the capital was not fruitful on account of a shortage of track in use, there is no other extraordinary first year charge, and future years must bring increased maintenance expenses. For instance, the maintenance of permanent way (excluding Lorain equipment) cost but ·025d. per car-mile, nothing being allocated to this heading for three months, and a paltry 1s. 6d. and 15s. 8d. for two other months out of the nine. In estimating expenses for the future, this item should be increased to at least 10 times the present figure. Possibly it is very low on account of contractors' guarantees operating. These guarantees being usually for one year, it is natural to assume that the permanent way account is not the only one which has benefited in this way.

Coming to general charges, we find that the management and clerical staff costs £750 per annum. This seems extraordinarily small, and we should be interested to know what proportions are charged of the salaries of the engineer and his assistants, and of the Town Hall staff who have to deal with legal and financial matters affecting the tramways.

The next item is absurd on the face of it. Rent, rates and taxes for the whole of the buildings, permanent way, land, income, &c., are charged at the rate of £312 per annum. The licenses of the cars alone account for 5 per cent. of that insignificant sum.

The last item we intend to criticise is insurance, which works out at £36 per annum. Of course, if the undertaking is safeguarded as the interests of the ratepayers demand, this covers the insurance of all buildings; all plant in the generating station and elsewhere used exclusively, or partly, for supplying energy to the cars; the rolling stock; third party accidents; workmen's compensation; and fidelity. Would the Corporation mind giving us, in confidence, the name of the insurance company which will effect *bonâ fide* policies of this description for £36 per annum?

A study of the monthly "profits" is instructive, for it shows that the average from May to October was £508 per month; while from November to January, *i.e.*, after the closing of the Exhibition, the figures are £21 per month, January showing an actual loss, even under Corporation accountancy, of £127.

Now let us indulge in a little arithmetic to prove to the people of Wolverhampton what their real prospects are.

An average taken of the results obtained by over 30 electric tramway undertakings of every class leads us to anticipate reductions as follows in the *normal* year's working at Wolverhampton:—

Passengers per car-mile reduced	from	10·9	to	8·9
Receipts „ „ „		12·8	to	11d.

On the reduced basis, the total receipts for the nine months would have been

$$\frac{323{,}673 \text{ miles} \times 11\text{d.}}{240} = £14{,}840,$$

which at once docks £17,592 − £14,840 = £2,752 off the declared profit, leaving £358 to cover depreciation, &c.

The same undertakings averaged an expenditure, excluding capital charges, of 7d. per car-mile. This, applied to Wolverhampton, gives a working expenditure of 323,673 × 7 = £9,440.

Therefore, the effect of the overhead system in Wolverhampton would have been to have given a balance of £14,840 — £9,440 = £5,400 for nine months = £7,200 per annum, or £3,050 per annum over the balance at the rate shown on the statement. We forgot for the moment, however, that the following bitterly significant statement forms a preface to the tabulated statement :—

"The whole of the figures in this statement relate solely and entirely to electric traction account, and no regard has been taken to the profit or loss resulting from the working of the horse tramways, or the interest and sinking fund on the purchase of the old undertaking."

As the loss on the horse tramways is reported to be about £3,000 for the year, and as the cost of the old undertaking was £26,750, it is evident that even the possible profit set out above would have been snatched from the grasp of the hungry ratepayers.

It should not be forgotten that the horse tramways would not have existed to make a loss if the Corporation had not indulged in the expensive pastime of experimenting.

The correspondence columns, and sometimes, we regret to say, the editorial columns as well, of the local papers, seem to indicate that the smooth and generally noiseless running of the cars is attributed to the superior merits of the Lorain system, instead of to the combined influences of the engineering staff, new cars, and new, unworn track. It should be unnecessary to say that, so far as smoothness of operation is concerned, there is no difference whatever between the overhead and the surface contact systems, so long as they are equal in point of age and efficiency of upkeep.

WIRELESS TELEGRAPHY IN THE UNITED STATES.

By E. GUARINI.

(*Continued from page* 684.)

We now come to the patents taken out by Prof. Fessenden, whose instruments, constructed by Messrs. Queen & Co., have been used for very interesting experiments by the Weather Bureau of the United States, and commented upon by several scientific journals, amongst others the Electrical Review in 1901.

We find in the Fessenden apparatus many points of interest, ingenious modes of arrangement, and a number of new ideas, some of which, perhaps owing to the incomplete

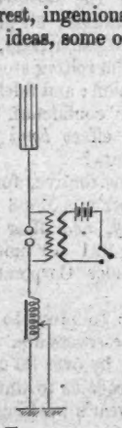


Fig. 10.

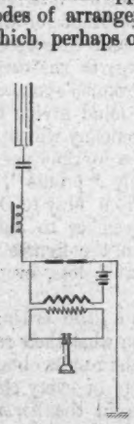


Fig. 11.

Fig. 12.

and vague way in which they are expressed, are incomprehensible to us, as to the majority of those that have studied the Fessenden patents.

Thus, the waves used by Prof. Fessenden are of a special kind. The inventor characterises them as follows in his American patent, No. 706,746 :—

"In the Lodge waves the electric energy is maximum when the magnetic energy is minimum, and all energy not absorbed by resistance losses is recoverable, while with the form investigated by me (Fessenden), the electric energy is maximum at the same time as the magnetic, and none of the energy radiated is recoverable except by deflection. I have found that it is essential for the proper sending and receipt of these waves, that the surface over which they are to travel should be highly conducting, more especially in the neighbourhood of the point where the waves are generated. I have found that this highly-conducting portion of the surface should extend to at least a distance from the origin equal to $\frac{\lambda}{4}$ of the wave in air, and in the direction toward the station to which it is desired to send the waves."

Reduced to its most simple expression the Fessenden transmitter (fig. 10) consists of a multiple antenna (previously described by Braun and by the writer in 1899, and afterwards applied to most systems) of great capacity, ending at one ball of the oscillator, the other ball being connected to earth through a tuning apparatus (capacity and self-induction) of a special form. Up to this point, with the exception of the form of the tuning apparatus, there is nothing new about it.

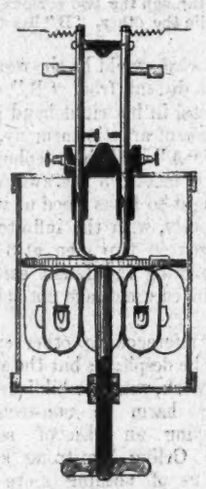


Fig. 13.

What, however, does constitute a real improvement, and one which will probably enable the speed of transmission to be greatly increased, is the way in which the oscillator is worked. In contradistinction to all the systems in which the coil is only influenced while the signals last, M. Fessenden makes it work during the whole of the time occupied by the transmission. It may be objected that, in this case, the receiver will not register dots and dashes, *i.e.*, distinct signals, but a continuous dash. This, however, is not the case, as Mr. Fessenden uses a syntonised apparatus and manipulates it by introducing the tuned arrangement for a longer or shorter interval (dot and dash). The great advantage of this method is seen at once; there is no starting of the interrupter, no self-induction or capacity to overcome in the primary circuit of the coil, no time lost in charging the condenser (discharging circuit). The time constant is therefore excessively small, and the speed of transmission consequently very great.

The receiver (fig. 11) consists of an antenna similar to that of the transmitter—practically it is the same—passing to earth through—(1) A condenser (as in the Cervera system which was tried in Spain). (2) A tuning arrangement similar to that of the transmitter. (3) A wave detector of a special form, based upon the long-known principle that the Hertzian waves, like any other current, heat a conductor and consequently cause its resistance to vary.

The detector, like the arrangement described in the writer's Belgian patent of June 24th, 1899, and in his English patent, No. 1,555, of January 24th, 1900, and like that afterwards adopted by Messrs. Ducretet and Popoff, is put in circuit with a battery and the primary of an induction coil, the secondary of which contains a telephone.

The Fessenden detector (fig. 12), which is very interesting in its construction, consists of a silver wire $\frac{1}{10}$ in. in diameter, containing a platinum core about $\frac{3}{1000}$ in. in diameter, drawn out until the outer diameter of the silver wire is not more than ·002 of an inch and the platinum wire ·00006 of an inch in diameter. A short piece of the wire with the

platinum core is bent in the form of a **U**, and its extremities attached to the entrance wire. The end of the **U** is immersed in nitric acid; the silver is dissolved and leaves the platinum bare. This method has for its object to reduce the heat capacity to the lowest possible value. Then, in order to facilitate the radiation of the heat, the detector is enclosed in a silver shell kept in place by a glass band attached to the entrance wires. The shell is, in its turn, enclosed in a bulb of glass in which at the last a vacuum is made. The resistance of the detector with the **U**-shaped

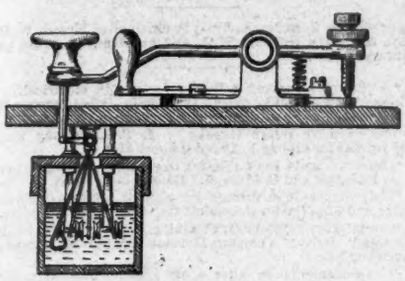


Fig. 14.

bend varies from 30 to 600 ohms, and is excessively low in comparison with the enormous resistance of a coherer. In practice, Mr. Fessenden does not use a single detector, but a certain number of detectors mounted on an insulating disc (fig. 13). By the action of a key, he replaces without any trouble a detector that has become useless.

In the circuit of the primary of the induction coil, Prof. Fessenden uses, instead of the ordinary Morse key, a key of a special type (fig. 14). This key, while it closes the circuit of the induction coil, works two electro-magnets, the purpose of which we will describe presently. The opening and closing of the circuit are effected in a bath of oil.

(*To be continued.*)

SUPPLY CANVASSING.

[COMMUNICATED.]

This is a subject which to some station engineers is a great worry, but to others no trouble at all, for the reason that they do not do any. One may envy the man who can dismiss the subject with the remark that his trouble is to get plant, not consumers; but experience shows that if early in the history of an undertaking the right sort of load is canvassed for and connected up, the rest being allowed to come on as plant capacity allows, the financial results are far better than they would otherwise be.

The chief reason why systemmatic canvassing has fallen into such evil repute is that it has often in the past been delegated to an erstwhile insurance agent or as a spare time job for the clerical staff. To be properly done canvassing should be done by engineers, or at any rate by a man thoroughly competent to advise as to probable cost of fittings and probable bill for energy, on the amount and best distribution of light, &c. A good address, too, is very necessary. Before starting the canvass of, say, a new undertaking, it has been found advisable to encourage local firms of good standing to take up a wiring department, as there is generally a distrust of unknown outsiders, especially in small towns. Notice, too, should be sent to the best known makers of electric motors and other suppliers that the works are about to start, as often invaluable assistance is gained thereby. The offices of the undertaking should be well lighted with representative types of house fittings, and it is well to have a small motor, a desk fan and a radiator or two connected up for show purposes. These can often be had on loan from makers, and the collection, combined with a visit to the engine room, will form a good excuse for inviting a possible consumer down and getting him interested. To begin the canvass, calls should be first made at the shops of hairdressers, as the light is here seen at its best, its coolness appreciated, and it becomes a topic of conversation. An early canvass should be made of the hotels, restaurants and bars, as these are usually very long-hour consumers; where new decorations are noticed, a special point should be made as to the cleanliness of the electric light. In dealing with tied houses, a short courteous letter to the brewers is advisable, pointing out the advantage to them of the adoption of the light.

In dealing with private houses, which really are the best lighting consumers, it is very necessary for the canvasser to have neat cards printed, and to be provided with illustrations of fittings, &c.

In canvassing for power supply, a start should be made by addressing, if possible, a personal letter to each likely firm, stating the fact that a supply is about to be given, the price per unit or per horse-power-hour, and that the writer would be pleased to call personally and give any desired information. In the event of any favourable reply, offers might be made of the services of the company's engineers in getting out specifications, arranging drives, &c. It should always be borne in mind—and this applies to lighting as well as power supply—that whatever may be the cause of any failure, the consumer will put the blame on the supply company, so that every endeavour should always be made to safeguard the interests of the consumer by thoroughly examining and testing all work connected to the mains, both during construction and on completion. At the same time, the relations between the company's staff and the local contractors as well as between them and the public, should always be courteous and friendly.

OUR LEGAL QUERY COLUMN.

[*Questions addressed to the Editors for insertion in this column should be written on one side of the paper. Free use of fictitious names, &c., may be made. Answers are furnished by a duly qualified lawyer, but the Editors cannot undertake to be responsible for the accuracy of the views which he may express.*]

"G. F. M." writes:—"I should be glad if through the 'Legal Query Column' of your paper you could let me know if a special, or any, sanction is necessary from the Board of Trade or Parliament to carry power (three-phase, say, 6,000 volts) along a country road for five miles from a large waterfall to a town, which town has a provisional order of its own; but the power would be supplied as above by a private company."

*** The Act of 1882, Sec. 14, provides that undertakers shall not be authorised to place any electric line above ground, along, over or across any street, without the express consent of the local authority. In these circumstances it is clear that "G. F. M." cannot lay his wires along the highway in the manner suggested without obtaining the consent of the local authority. If the consent of the local authority is obtained and the Board of Trade regulations are duly observed, the wires can be set up. There is no necessity for any application for a provisional order. Of course "G. F. M." may think it better to apply for a provisional order for the sanction of his undertaking. If he does not do so, however, he will be well advised to procure a copy of the "Regulations" prescribed by the Board of Trade under Sec. 4 of the Electric Lighting Act, 1888, which may be procured from Messrs. Eyre & Spottiswoode, London, E.C. These regulations show exactly at what height he must put his wires, and also prescribe the limits which are to be observed with regard to pressure, &c.

CARE OF TROLLEY WHEELS AND STANDS.*

By FRANK BERRY, Jr.

The tension applied to a trolley pole is a very important factor in the life of both the trolley wheel and the wire. The life of a trolley wheel is, of course, affected by the pressure with which the trolley wheel is held against the wire, by the amount of current that it passes, and by the grade of material of which it is made. The tension springs on the trolley stand should always be so adjusted as to give the trolley wheel a firm contact against the trolley wire at that point on the road where the wire is at its greatest height above the roadbed, and no more, as excessive tension will lessen the life of the trolley wheel a considerable number of miles, besides wastefully cutting the trolley wire. No specific rule can be set down for the proper amount of tension to give a trolley pole, as under some conditions of operation heavy trolley wheels are required, and then more spring tension is, of course, required to produce the required degree of pressure against the trolley wire than if a lighter wheel were used.

It is a well known fact that the motorman's methods very greatly affect the life of a trolley wheel. For instance, if a motorman is

* *American Electrician.*

careless about going over section breakers, frogs and crossings, and allows the power to remain on when it should be off, destructive arcing will occur which will make flat spots on the trolley wheel, and these cause worse arcing by improper contact and rapidly wear out the trolley wheel.

The fit of the trolley wheel in the trolley harp also affects the good running qualities of the wheel. A newly bushed trolley wheel should fit easily over the axle pin, and the end play should be taken up by threading on copper washers, leaving, of course, enough end play to prevent the trolley wheel from wearing a ridge in the axle. Trolley-wheel axles, when they become unduly worn, should not be used, as they chew up the trolley bushings, and a wheel should, of course, be discarded before it splits in half, as the wear on both the trolley axle and trolley wire is increased by allowing it to run too long.

Although an anti-friction metal is used in the trolley bushing, a little oil applied occasionally will increase the life of the bushing. As previously stated, the life of a trolley wheel depends partly upon the amount of current that the wheel has to pass. On cars, for which the amount of current required has been increased, the life of the trolley wheel will be decreased. It is important, therefore, to use trolley wheels of a diameter large enough to give ample contact surface on the trolley wire for the amount of current that is to be passed at the outset; then no serious trouble will develop if the current is afterwards increased. The proper diameter for any case can really be determined only by actual experiment, taking complete notes of the behaviour of each of several sizes of wheel during a series of trial runs.

NEW PATENTS APPLIED FOR, 1903.

Compiled expressly for this Journal by W. P. Thompson & Co., Electrical Patent Agents, 322, High Holborn, London, W.C., and at Liverpool, to whom all inquiries should be addressed.

8,414. "Improvements in electric lamps." C. G. Fernie. April 14th.

8,417. "Improvements in electric dynamo machines." T. R. Hill. April 14th.

8,436. "Improvements in permanent magnet electric generating machines." G. W. Somerville, O. Hicks, and Howard & Bullough, Ltd. April 14th.

8,442. "Improvements relating to electrical cut-out or fuse holders." A. H. Hickley. April 14th.

8,448. "An improved method of operating ships' steering gear or lifting apparatus by electrical means." J. G. Kuhn. April 14th.

8,472. "Improvements in electric motors." A. Kimble and F. S. Betz. April 14th. (Complete.)

8,474. "Improvements in and relating to electric ignition devices for internal combustion engines." R. S. Lovelace. April 14th.

8,480. "Improvements in electric heaters." J. E. Dube. April 14th. (Complete.)

8,488. "Improvements in or relating to magneto-electric generators." B. P. Remy and F. I. Remy. April 14th. (Complete.)

8,491. "Improvements in or relating to automatic contacts for telephones and like circuits." W. A. W. E. Hjorth. April 14th. (Complete.)

8,497. "Improvements in and relating to electric dynamos and motors with alternating field." R. Ziegenberg. April 14th. (Complete.)

8,507. "Improvements in space or wireless telegraphy." W. P. Thompson. (J. S. Stone, United States.) April 14th. (Complete.

8,508. "Improvements in space telegraphy." W. P. Thompson. (J. S. Stone, United States.) April 14th. (Complete.)

8,509. "Improvements in wireless telegraphy." W. P. Thompson. (J. S. Stone, United States.) April 14th. (Complete.)

8,512. "Improvements in electric arc lamps." F. W. Gore. April 14th. (Complete.)

8,546. "An improved brush-holder for electric motors and dynamos." E. J. S. Wheatcroft. April 15th.

8,550. "Improvements in connection with the controlling of electric tramcars and other vehicles." A. James and F. Bryan. April 15th.

8,560. "System of driving for electrical power plants, and especially for electric railways." J. Sahulka. April 15th. (Complete.)

8,570. "Improvements relating to electric arc lamps." Mme. Klostermann, née M. Hermann. April 15th.

8,584. "Improvements in or relating to electric signalling apparatus for railways." A. Oesterreicher and L. Nemelka. April 15th. (Complete.)

8,615. "A device for electrically opening, closing, unlocking, and locking, of doors, the lighting of incandescent lamps and ringing of electric bells." J. E. Rison and W. F. Bott. April 16th.

8,648. "Improvements in electric lamps for use in connection with bakers' ovens and the like." N. A. Mingay. April 14th.

8,658. "Improvements in and relating to electrical transformers." H. Loewenstein and H. Loewenstein. April 16th. (Complete.)

9,664. "Improvements in systems of electrical signalling for railroads." C. Barber. April 16th. (Complete.)

8,670. "Improvements in alternating electric current meters." E. A. Carolan. (The General Electric Co., United States.) April 16th.

8,676. "Improvements in and relating to plates or electrodes for electrical accumulators." A. Cance. April 16th.

9,679. "Improvements in apparatus for electro-plating. P. Hubert. April 16th.

8,690. "An electrical burglar alarm for protection of safes, vaults, and the like." J. Weatherby. April 16th. (Complete.)

8,746. "Improvements in fuse boxes for electricity supply mains." G. W. Goldring. April 17th.

8,774. "Improvements in wireless telegraphy." W. H. Wheatley. (E. C. Lewis and C. Armitage, United States.) April 17th.

8,778. "Improvements in electrically-propelled vehicles." L. Krieger and La Compagnie Parisienne des Voitures Electriques (procédés Kriéger). (Date applied for under Patents Act, 1901, September 22nd, 1902, being date of application in France.) April 17th. (Complete.)

8,787. "Improvements in electricity meters." The Electric and Ordnance Accessories Co., Ltd., and L. J. Aron. April 18th.

8,791. "Improvements in electrostatic voltmeters." J. Ferguson and Kelvin & J. White, Ltd. April 18th.

8,800. "Improvements in interlocking electric switches and cut-outs or the like, and circuit-breakers, suitable for use in mines or the like situations." A. Eckstein and A. J. D. Krause. April 18th.

8,810. "Improvements in electric cables." E. A. Claremont and C. J. Beaver. April 18th.

8,812. "Improvements in means for automatically regulating electric circuits." H. Leitner. April 18th.

8,826. "Improvements in and relating to apparatus for playing a game of skill, and administering electricity to the successful player." H. C. Ross. April 18th.

8,831. "Improvements in the compounding of synchronous alternators for single and polyphase electric currents." A. Heyland. April 18th.

8,844. "Improvements in and connected with electric fuses." J. N. Dauncey and J. A. Wilding. April 18th.

PUBLISHED SPECIFICATIONS, 1901.

Copies of any of these Specifications may be obtained of Messrs. W. P. Thompson and Co., 322, High Holborn, W.C., and at Liverpool, price, post free, 9d. (in stamps).

21,974. "A new or improved collector for use in electrically-propelled or lighted vehicles." W. Griffiths and B. H. Bedell. Dated October 31st.

21,981. "Improvements in and connected with galvanising as a means of actuating one or more relays thereby." J. T. Armstrong and A. Orling. (Patent not yet due for sealing.) Dated October 31st.

21,984. "Improvements in or relating to electric coils for an oscillatory discharge." A. Radiguet and G. Massiot. Dated October 31st.

22,012. "Improvements in fittings for conduit systems of electric wiring." L. H. Lander and Simplex Steel Conduit Co. Dated November 1st.

22,031. "An improved system for obtaining variable speeds in direct-current electric motors." British Thomson-Houston Co. (J. A. Essberger, Berlin.) Dated November 1st.

22,033. "Improvements in alternating electric current motors." H. M. Hobart. Dated November 1st.

22,037. "Improvements in armature windings for dynamo-electric machines." H. M. Hobart. Dated November 1st.

22,110. "Improvements in or relating to electric motors." O. H. Pieper and A. F. Pieper. Dated November 2nd.

22,152. "Improvements in electric cable conductors." W. E. Hitch. Dated November 4th.

22,188. "Connections for telephone exchanges with automatic switching off of the operator's telephone." H. Oppenheimer. (Actiengesellschaft Mix and Genest, Berlin.) Dated November 4th.

22,200. "Improvements in or relating to electrical systems for operating signals, points, bolts or other railway apparatus." A. J. Boult. (A. Neeleman, Belgium.) Dated November 4th.

22,219. "Improvements relating to electric telegraphy." D. Murray. Dated November 4th.

22,220. "Improvements relating to perforators for electric telegraphs." D. Murray. Dated November 4th.

22,279. "Improvements in electric motor control systems." A. H. Armstrong. Dated November 5th. (Date applied for under Sec. 103 of Patents, &c., Act, 1883, April 8th.)

22,290. "Improvements in or relating to outlet boxes and terminals for electrical conduits." A. G. Brookes. (R. M. Thomas and H. D. Betts, United States.) Dated November 5th.

22,307. "Improvements in and relating to systems of, and apparatus for, transmitting movements, signals and the like. W. Thierman. Dated November 5th.

22,477. "Improvements in electric meters." W. G. Johnson. (Hartmann and Braun, Germany.) Dated November 7th.

22,541. "Improvements in air-pump governors." British Thomson-Houston Co. (S. B. Stewart, United States.) Dated November 8th.

22,543. "Improvements in systems of electric circuits for controlling electric motors." British Thomson-Houston Co. (F. E. Case, United States.) Dated November 8th.

22,544. "Improvements in circuit breakers for electric currents." British Thomson-Houston Co. (R. H. Read, United States.) Dated November 8th.

22,545. "Improvements in incandescent electric lamps." British Thomson-Houston Co. (J. W. Howell, United States.) Dated November 8th.

22,546. "Improvements in systems of electric motor control." British Thomson-Houston Co. (A. S. Garfield and C. E. d'Ornellas, Paris.) Dated November 8th.

22,582. "A new and improved telephone system." G. Amberg. Dated November 8th.

22,640. "Improvements in automatic apparatus for controlling and operating the points of electric railways and tramways." T. B. Stewart and W. H. Turner. Dated November 9th.

22,647. "Improvements in electric motor control systems." British Thomson-Houston Co. (W. B. Potter, United States.) Dated November 9th.

22,658. "Controlling apparatus for electrically propelled trams." C. de Kando. Dated November 9th.

22,710. "Improvements in telegraph and telephone systems." L. Cerebotani and C. Moradelli. Dated November 11th.

22,711. "Improvements in apparatus for reversing the motion of a reciprocating body by electric current impulses transmitted through a single line." L. Cerebotani and M. Bernstein. Dated November 11th.

22,844. "Improvements in and relating to apparatus for perforating the tape used in automatic telegraphic instruments." J. Gell. Dated November 12th.

22,888. "Improvements in and pertaining to electric railways." W. Le Wise. (Maschinenfabrik Oerlikon, Switzerland.) Dated November 12th.

22,898. "Improvements in the lapping leads used in electric cable-making machines." E. A. Claremont and J. B. Hyde. Dated November 13th.

22,899. "Improvements in wattmeters." W. du B. Duddell and T. Mather. Dated November 13th.

22,921. "Improvements in selective systems for electrical communication." S. A. Reed. Dated November 13th.

22,924. "Improvements in means or apparatus for electrically transmitting and receiving messages." A. T. M. Johnson and G. Guyott. Dated November 13th.

22,937. "Improvements in electric relays." Siemens Bros. & Co., and G. Forrest. Dated November 13th.

22,958. "Improvements in or relating to electro-magnetic cut-outs." E. L. Joseph and G. Gardner. Dated November 13th.

22,990. "Novel or improved insulating composition for electrical purposes, and a method of applying the same." J. W. Sankey. Dated November 14th.

1902.

146. "A method of utilising two conductors and earth for transmitting a number of efficient electrical conductors." C. M. Jacobs. Dated January 2nd.

1,544. "Improvements in flash lights and electric igniters therefor." H. H. Lake. (Communicated.) Dated January 20th.

1,767. "Improved device for varying the speed of continuous current electric motors." A. G. Bloxham. Dated January 22nd.

2,058. "Improvements in rail bonds or connecting strips for the rails of electric railways." G. W. Blanchard. Dated January 25th.

4,805. "Improvements in electro-dynamometers." R. Ziegenberg. Dated February 25th.